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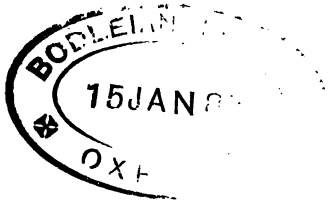
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15JAN
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BOROUGH OF BIRMINGHAM.

Extract from the Minutes of the Council,
3rd October, 1871.

7907. *Resolved*—"That the Report of the Sewage Inquiry Committee be received and entered on the Minutes, and that the same be printed, and a copy forwarded to each member of the Council; and that such Report be taken into consideration at a Special Meeting, to be convened for that purpose."

E. J. HAYES,
Town Clerk.

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BOROUGH OF BIRMINGHAM.

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REPORT

OF THE

SEWAGE INQUIRY COMMITTEE.

PRESENTED TO THE COUNCIL

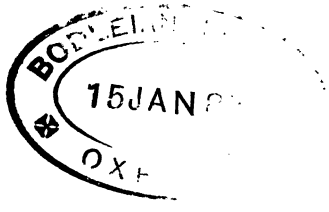
ON THE 3RD OF OCTOBER,

1871.

LONDON:
SIMPKIN, MARSHALL, AND CO.
BIRMINGHAM:
CORNISH BROTHERS, 37, NEW STREET.

1871.

c Gough Warwick, 4° 11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E. J. HAYES,
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SEWAGE INQUIRY COMMITTEE.

REPORT for Presentation at the Adjourned Quarterly Meeting of the Council, 3rd October, 1871.

THE SEWAGE INQUIRY COMMITTEE have, since their appointment, held 19 meetings.

The Mayor attended 10 of such meetings.

	ATTENDED.	ABSENT.
Alderman Avery, Chairman...	19 ...	—
„ Hawkes	14 ...	5
Councillor A. Barratt, M.D....	18 ...	1
„ Chamberlain	— ...	19
„ Jesse Collings	13 ...	6
„ Harris	15 ...	4
„ Lowe	18 ...	1
„ Edmund Tonks, B.C.L.	18 ...	1

SUMMARY.

BIRMINGHAM SEWAGE INQUIRY COMMITTEE.

SUMMARY OF THE REPORT.

The report of the Sewage Inquiry Committee having necessarily extended to considerable length, it is thought desirable, for the convenience of the Council, to prefix to it a Summary of its contents.

The Committee were appointed to inquire into two subjects—the "best mode of disposing of, or dealing with, the sewage of the borough;" and the possibility of "excluding from the sewers all excreta, and other animal and injurious matters that tend to cause the sewage, as now discharged, to become a common nuisance."

The results of the inquiries thus directed, and the recommendations of the Committee arising therefrom, are now presented, in two main divisions—(1) the Exclusion of Excreta and other Injurious Matters from the Sewers; and (2) the Treatment of the Sewage at the Sewers' Outlet.

Under the former division some account is given of the methods in use in other large towns; and under the latter division the treatment of sewage is considered in regard to the methods of Precipitation; Filtration; and Irrigation—the various processes incident to these systems

Summary

being described, and reports being furnished of inspection of sewage farms.

Special reports and communications on the several matters of inquiry have been obtained from the Borough Surveyor, the Borough Analyst, and the Inspector of Nuisances; and from Mr. Hope, of Romford, Mr. Bailey Denton, C.E., Mr. Hawksley, C.E., and Professor Frankland. These are embodied in the Report. Other communications, of great value, from Mr. George Shaw, F.G.S., and other gentlemen, are published in an Appendix to the Report.

In reference to the first branch of their inquiry—the exclusion of injurious matters from the sewers—the Committee are informed by the Borough Surveyor that no better method than the gully traps now in use can be devised to prevent the intrusion of road detritus, and the consequent increase of the sewage by accumulations of solid matter, requiring to be subsequently removed by deposition. The Committee, however, believe that much benefit in this direction would result from a more systematic paving of yards, courts, footpaths, and carriage-ways.

As regards the pollution of the sewage by other than fœcal matter, the Committee find that it is desirable to exclude the liquid refuse from stables, cow-houses, slaughter-houses, and from certain classes of manufactories. Specimens of refuse from the following trades—brassfounders, galvanisers, manufacturing chemists, wire drawers, and German silver manufacturers—were obtained by the Borough Surveyor, and submitted to Professor Frankland, of the Royal College of Chemistry, for analysis. His report states that pickling or ferruginous liquids, such as those collected from the works of German silver manufacturers, galvanisers, and wire drawers, and also carbolic acid, and similar products derived from wood or coal tar, ought to be excluded from the sewers, and that this may be effected without injury to the manufacturers, as "the pickling and ferruginous liquids can be converted into marketable salts, which will nearly, if not quite, repay the cost of their manufacture,"

Summary

while the acids and tar products can be disposed of by being evaporated in the ashpits of any furnaces used in the factories where they are produced. The Committee, therefore, recommend that powers shall be obtained to compel the exclusion of such refuse from the sewers.

The exclusion of animal excreta from the sewers is, in the opinion of the Committee, essential both to the effectual treatment of sewage and to the health and comfort of the population; and they have arrived at the conclusion that this object may be attained by a reform of the system of exposed privies and open middens, now prevailing in the town, and which defile the air, poison the water, and, by means of connecting drains, pollute the sewage.

The extent of the midden system is now for the first time ascertained. There are in Birmingham 3,884 premises, containing 7,065 water-closets, accommodating about 20,000 persons; and 70,000 houses, connected with 19,551 privies and middens, accommodating about 325,000 persons. Of these middens or ashpits, nearly 14,000 are drained into the sewers. The middens cover an area of 65,170 square yards, or about 13½ acres; and practically all of them, containing fœcal matter and solid and liquid refuse, are open to the air. Some of them are situated beneath houses or workshops, and large numbers are built against the walls of houses, which are thus permeated with the filthy liquid soaking through the walls. The consequence is that the sewers are constantly fouled by the drainage from the middens, and that the surface wells generally become the receptacles of sewage matter, with which the earth surrounding the middens is absolutely saturated.

In connection with this branch of their inquiry, the Committee have made themselves acquainted with the condition of several other large towns—in particular, Liverpool, Manchester, Rochdale, Leeds, Nottingham, and Hull. In all these towns they find that the midden system is condemned, and is being replaced, experimentally, by

Summary

other systems. In Liverpool, water-closets are largely adopted, and movable ashbins are supplied for the reception of solid refuse. In Manchester, the midden system is found to be seriously detrimental to health, and the substitution of covered ashpits, with a new kind of privy, is rendered obligatory, at the cost of owners. The privy (of which a description is given on page 25 of the Report) is so contrived that ashes can be emptied only through the seat (capable of being raised for this purpose), and therefore the fœcal matter is deodorised. This system is easily worked, even in the lowest quarters of the city, and has resulted in a better class of tenants, increased value of property, and improved condition of public health. At Rochdale, also, the midden system is condemned and prohibited. The ordinary privies are replaced by others in which receptacles, containing disinfecting fluid, are placed beneath the closet seats, and these receptacles are removed weekly in covered carts (of which, and of the privies, drawings will be found in an Appendix to the Report). Tubs, emptied when full, are provided for the reception of ashes and other solid refuse. The cost of the alteration (effected by owners) is stated as averaging £2. This system is also adopted, with advantage, at the Birmingham Workhouse. No difficulty is experienced in working it at Rochdale. The condition of Leeds very much resembles that of Birmingham, in regard to the midden system, which is described in a report of Mr. J. Netten Radcliffe to the Medical Department of the Privy Council (1870) as "the filthiest and most unwholesome mode of excrement disposal." On the same authority, it is stated that "excrement-sodden earth, excrement-polluted air, and excrement-tainted water are the principal factors of the production of diarrhœa and enteric fever;" and, again, that "the condition chiefly provocative of these diseases exists in its most dangerous form in improperly constructed and arranged, and imperfectly acting or stagnant sewers, containing excrement." The Government Inspector advises, in regard to Leeds, the filling up of middens, the provision of water-tight closed receptacles for excrement and ashes, and frequent periodical removal of such matters. These recommendations have

been approved and adopted by the Corporation of Leeds, and owners of property are now being required to carry them into effect. At Nottingham, also, the tub-closets are in course of substitution for middens; and improved closets are being adopted at Hull. Summary

As the result of these inquiries the Committee recommend, as before stated, the exclusion of certain manufacturing refuse from the sewers; and the interception of refuse from slaughter-houses, cattle-markets, urinals, cow-houses, and stables. They recommend, also, the preparation of a register of all connections with the sewers, and the prohibition of new connections without consent of the Town Council. They further recommend the gradual abolition of middens, and the substitution of a new privy system, entirely unconnected with the sewers, and they advise an experimental trial of the Rochdale and Manchester systems, with the view of extending to the whole of the borough that which shall prove to be most efficient. In this way, the greater part of the excreta now finding its way into the sewers will be intercepted; a great sanitary reform will be effected; the cost and difficulty of dealing with the sewage at the outfall will be lessened; and the cost of the Night Soil Department will be diminished. As regards the comparatively small number of water-closets now connected with the sewers, the Committee do not recommend their abolition, on account of the difficulty of replacing or altering them, and because they are less exposed to sanitary objections. The Commitee, however, recommend that a tax shall be imposed upon water-closets, on the principle that persons who, by their means, introduce fœcal matter into the sewers, may fairly be called upon to pay the cost of its necessary subsequent extraction.

Having thus provided, as far as possible, for the purification of the sewage by the exclusion or interception of excreta, the Committee proceed to the second branch of their inquiry—the Treatment of Sewage at the Outfall, which involves the disposal of a dry weather flow of 17,000,000 gallons daily, in such a manner as to satisfy the

Summary

injunctions of the Court of Chancery, by avoiding the creation of a nuisance at the outlet, and by preventing the pollution of streams into which the effluent water is discharged.

To effect this it is necessary to extract the solid suspended matters and the polluting matter held in solution, before passing the volume of sewage water into rivers.

Various processes recommended as capable of accomplishing these objects, have been examined by the Committee. These processes are classed under the heads of (1) Precipitation; (2) Filtration; (3) Irrigation.

Precipitation consists in adding to the sewage various chemical re-agents, with the object of precipitating (or throwing down) a portion of the dissolved constituents, and of assisting the precipitation of the suspended constituents; and ultimately of realising the value of the precipitate as manure. The methods examined by the Committee are the lime process; lime and chloride of iron; Holden's process, sulphate of iron, lime, and coal; Bird's process, sulphate of alumina, with subsequent filtration through coke; Lenk's process, chiefly alum; Forbes's process, phosphate of alumina; and the A B C system, alum, blood, clay, and charcoal.

The conclusion the Committee have arrived at is that systems of precipitation are so uncertain that satisfactory results cannot be relied upon, or so inadequate to the requirements of a great bulk of sewage matter that they cannot be justifiably recommended for application to the sewage of Birmingham.

Filtration consists of an endeavour, by mechanical and chemical means, to arrest the suspended matter in sewage, and to subject organic matter, both suspended and dissolved, to a rapid process of oxidation, and thus to render them harmless. The principal system examined is that known as Weare's patent, now in course of trial at Stoke-on-

Trent. Filtration by a charcoal process, tried at Uxbridge; and a clay process, tried at Ealing, have likewise been inquired into. A full account of these processes in given in the Report, but, for the reasons there stated, the Committee do not recommend that any trial shall be made in Birmingham. Summary

Irrigation, the third system of sewage treatment, may be thus described:—Land is a natural filter, and, if the purification of sewage alone is contemplated, a comparatively small area, used simply as a filter bed, may suffice, if the filtration is intermittent, to purify sewage so as to allow of its admission into a running stream; but if it is also required to utilise the elements of fertility which the sewage may contain, a vastly larger area is necessary, if the sewage is to be applied so as to produce the greatest return, in the shape of marketable crops, without injuring the permanent fertility of the soil."

The Committee therefore proceed to consider this method under the two heads of *Utilisation* and *Purification:* in other words, respectively, the use of sewage upon land so as to make a profit by cultivation; and the use of land as a means of purifying sewage, so as to allow of it being harmlessly passed into water-courses.

In regard to Utilisation three questions have to be considered—(1) Is sewage valuable enough to warrant the cost of preparing land to receive it? (2) Can sewage without injury to the soil, be permanently employed? (3) How much land (proportioned to the volume of sewage) is required for perfect utilisation, so that no fertilising elements shall be wasted? These questions, it appears to the Committee, are at present unsolved. Chemists and agriculturists are not only doubtful in respect of them, but are absolutely and irreconcileably conflicting in opinion. All considerable and careful attempts to utilise sewage are of recent date, and therefore most imperfect guidance is yielded by experience. Consequently, in undertaking the vast and most costly

Summary

experiment which would be requisite for Birmingham the utmost caution is necessary.

Visits were paid by the Committee to several sewage farms, and inquiries were made in respect to others. Full information of the places visited is given in the Report. Some general figures only need be quoted here, as a guide to the quantity of land required, and the flow of sewage it is capable of receiving :—

Town.	Population.	Acres Irrigated.	Persons per acre.	Tons of sewage applied yearly.
Warwick	11,000	135	81	6,372
Rugby	8,000	65	123	5,065
Romford	7,000	121	58	3,324
Bury	15,000	26	577	9,400
Cheltenham	40,000	330	121	4,937

Thus, the quantity of land, the proportion of population to acreage, and the quantity of sewage applied per acre, vary so much that no certain conclusions can be derived from these figures. The quality of the land is clay at Cheltenham and Warwick; gravel upon clay at Rugby; and light, with gravel subsoil, at Romford and Bury. The crops are chiefly rye-grass, vegetables, and a small quantity of cereals. Financial results are nowhere distinctly ascertained, the system not yet being sufficiently developed, but it is apparent that a heavy loss (especially upon a large scale of irrigation) is almost inevitable where irrigation is conducted by municipal authorities As to other results of the system, the Committee learn by answers to inquiries sent out, that land improves greatly under irrigation, that, as a rule, no complaints of nuisances are made; that the health of irrigated districts is not injuriously affected; that cattle thrive on the irrigated land; that no other than sewage manure is found necessary; and that the sewage water, after passing through the land, is purified in a satisfactory manner. The details of this information will be found in an Appendix.

As to the quantity of land required for utilisation, it has been shown that the recorded experiments vary so

much as to render them unsafe as the bases of positive conclusions. It is obvious that when a large quantity of sewage is used per acre, rye-grass and green vegetables are the crops most readily grown. Assuming the average quantity of sewage per acre (5,768 tons yearly) to be poured upon the land, not less than 4,800 acres would be necessary to utilise the sewage of Birmingham for the growth of rye-grass and green crops. But local experience renders it manifest that such an area could not be used with advantage, for the rye-grass now grown upon part of the 140 acres of the Corporation sewage farm at Saltley can scarcely be disposed of, and how much greater must the difficulty of disposal become, supposing the requisite quantity of 4,800 acres to be employed for the growth of such crops as those above described? It necessarily results that if the sewage of Birmingham is to be disposed of by the system of utilisation, this can be effected only by its application to ordinary farming, and in that case the estimated quantity of 4,800 acres must be at least doubled. Indeed, Mr. Hope, the most eminent authority on sewage farming, estimates that less than 10,000 acres would not suffice for the purpose. The cost of preparing this vast tract of country for the reception of sewage, by laying out the surface, and deep drainage, would probably amount to £25 per acre, or £250,000.; independently of the purchase of land, and the construction of the necessary receiving tanks, and the conduits for conveying the sewage to the land. Taking into account the uncertainty and the difficulty of utilisation upon a large scale, and acting in accordance both with the results of their own inquiries, and the best advice they have been able to obtain, the Committee cannot recommend the adoption by the Council of a scheme of sewage utilisation in regard to Birmingham.

Summary

The plan which, after the fullest inquiry and consideration, the Committee recommend for adoption is that of *Purification* of the Sewage by *Intermittent Downward Filtration;* in other words, the application of sewage to a moderate quantity of land, so as to make purification the first object, and cultivation only the second, with the view

Summary

of passing the purified effluent water as quickly and cheaply as possible into the river.

There is no doubt that sewage may be effectually cleansed by filtration through a very small area of land. On the estimate of the Rivers Pollution Commissioners, 175 acres would suffice to purify the sewage of Birmingham; and on the estimate of Professor Voelcker, 350 acres would be sufficient. These areas, however, would necessarily require to be constantly used, and would thus become clogged, with the possible result of creating a nuisance by the deposit of the fœcal matter suspended in the sewage. A very small area would therefore render impossible the application of an intermittent process, and would afford no opportunity of turning the sewage in any way to account as a fertilising agent, or of enabling part of the land to be used as a model farm, for the instruction of agriculturists as to the use and capabilities of sewage as a manure. The Committee, therefore, recommend the acquisition of 800 acres of land in a suitable locality, and this quantity, together with the 140 acres now occupied by the Corporation at Saltley, will amply satisfy all the requirements above described.

In reference to the method of treating sewage, and the amount of land required, the Committee consulted Mr. Hope, of Romford, a most eminent authority on sewage utilisation; and Mr. J. Bailey Denton, C.E., who has been appointed by the Court of Chancery to supervise a system of sewage treatment at Merthyr Tydvil, under circumstances very similar to those of Birmingham. The Committee also consulted Mr. Hawksley, C.E., as an engineer specially competent to advise upon this subject.

Mr. Hope furnished two reports for the information of the Committee. In the first report he insists that partial utilisation of sewage is impracticable; if a system of utilisation is entered upon it must be complete, and thus an enormous area of land would become necessary—at least 10,000 acres for the proper treatment of the sewage of

Summary

Birmingham. As, in the present state of the question, it is unadvisable to incur this gigantic outlay, Mr. Hope, speaking from experience, advises the acquisition of about 1,000 acres of land, sufficient to purify the sewage by intermittent downward filtration; 750 acres of the land to be used for this purpose, combined with the growth of green crops, and 250 acres to be used as a model farm for the instruction of agriculturists in the uses and value of sewage manure. In a second or supplementary report, Mr. Hope recurs to the subject, and strongly repeats his advice in favour of intermittent downward filtration. Referring to the proposal already before the Council for the purchase of a large area of land for sewage utilisation, he says (Report, p. 91), "Having regard to all the circumstances of the case, I make a definite and precise recommendation, of which I accept the full responsibility. I say, do not waste your money in buying an area of land which, large as it is, would be quite insufficient to enable you to utilise all the manure of Birmingham; but buy only enough for a large filter, and supplement this by a small model farm, as a school for future customers, who will in a little time be very ready to buy all the manure you can sell them at a fair price." Mr. Hope adds that the varying areas proposed in the Report of the Public Works Committee for the utilisation of the sewage of Birmingham—from 1,645 to 8,000 acres—are utterly insufficient; the former being much too large for purification by filtration, and the latter being quite inadequate to the utilisation of the sewage of 350,000 persons; besides which, he points out, farmers are not yet sufficiently experienced to know how to use sewage upon a large scale, so as to get its full profit, and not to create a nuisance, and therefore they need to be taught by experiments of moderate extent. Mr. Hope concludes—"Having laboured so long and earnestly in the cause of sewage utilisation, I shall be mortified beyond measure if I see the first large town which adopts irrigation proceeding in the matter in a way that must involve a long period of confusion and loss before any good result is attained, and so again bring sewage irrigation into disfavour."

Summary

Mr. Bailey Denton advises the purchase of 900 acres of land for the purpose of intermittent downward filtration; the land to be divided into three areas, say of 300 acres each: any one of the three being sufficient to receive the sewage for six or twelve months, as may be decided upon, leaving the others at rest. Mr. Denton is of "opinion that this arrangement may be made a lasting one, and will render the effluent water admissible into the river Tame without any nuisance whatever." He further considers that a small part of the land should be used as a model farm, to show farmers what can be done with sewage in the way of ordinary irrigation; and he adds, "Experience at Merthyr justifies my stating that not only may crops be produced from the two series of areas which will be at rest, but that the series of areas at work may also be made equally productive."

Mr. Hawksley commences his report with an observation which should be carefully borne in mind in all discussions as to the disposal of sewage. He says that while the art of removing excretal refuse in water has been brought to perfection, the problem of repurification of the polluted liquid remains unsolved. To deal with the sewage of small communities is easy, but difficulty and expense become augmented into great and even impossible proportions when the sewage of hundreds of thousands of persons has to be dealt with. The method which in a small community may cost £1. per head, may in the case of a large community involve an expenditure of £3., £4., or £5., per head. Therefore it is unsafe to conclude that because some plan of sewage disposal has succeeded in one district, it is equally certain to succeed in another. This remark, Mr. Hawksley observes, forcibly applies to the defœcation and utilisation of sewage by irrigation, in regard to which the conditions of small and large communities are essentially different. Supposing Birmingham to be converted into a water-closet town (which is what a system of sewage utilisation by irrigation really involves) then, in Mr. Hawksley's judgment, the difficulty now experienced will become incalculably greater. "The quantity of fœcal matter in the

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sewage will become increased more than ten-fold, and if the statistics supplied to me be even approximately correct, to almost twenty-fold. There is, however, no instance in which the defœcation of sewage containing so vast an amount of fœcal matter—the excreta of 350,000 people—has been as yet attempted, whether by irrigation or otherwise; nor is it possible from any existing experience to predicate what may be the pecuniary and sanitary difficulties to which the attempt to accomplish this object might ultimately lead. Of one important fact we are however assured, namely, that the strongest legal obligations imposed by the Legislature, and enforced by the Courts of Law and Equity, will necessitate the acquisition from time to time, and at any cost, of greater areas of land and of larger operations, until the effluent water shall at length regain from any extreme of pollution that high standard of purity which, according to modern views, is necessary to render it legally admissible into any public stream."

In regard to the treatment of the sewage of Birmingham, Mr. Hawksley advises the removal, by deposition or precipitation, of suspended matters, and the subsequent floating of the clarified sewage upon land, for the purpose of purification, before the finally effluent water is allowed to pass into the River Tame. The land in a portion of the Tame Valley, a little south of the hamlet of Blackgreave is, from its constitution, perfectly adapted to this purpose. When laid out for the production of grass crops, and thoroughly and closely under-drained, so as to give the largest possible filtering medium, "a comparatively small area of this land would be found adequate to the sufficient oxidation of the liquid sewage"; and then, Mr. Hawksley remarks, "we may fairly dismiss any apprehension that the sewage would return to a foul or objectionable state after its admission into the River Tame, provided only the crude sewage be previously freed by any available means from the noisome matters it holds in suspension."

The quantity of sewage to be dealt with amounts, as estimated by Mr. Hawksley, to a daily minimum flow of

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16,000,000 gallons, and a maximum flow (storm water) of 32,000,000. Mr. Hawksley recommends that the present Saltley works at the outlet (which are unsuited to the treatment of so large a volume of sewage) be discontinued, so far as regards the detention and accumulation of depositable solids, the road detritus excepted. This will satisfy the injunction obtained by the residents in the neighbourhood. As to the injunction obtained against fouling the River Tame, Mr. Hawksley advises that it shall be met by removing from the river, above Hams Hall, the whole of the liquid sewage. With this view it will be necessary to construct an open conduit about 7½ miles in length, and capable of carrying 3,200,000 gallons an hour, to suitable lands in the Tame Valley, lying well to the north of Hams Hall, and, preferably, a little south of the hamlet of Blackgreave. At Saltley he would add to the raw sewage a small quantity of a cheap sulphate of alumina, to facilitate the separation of the solid matter, and afterwards, if necessary, at some other point, a small quantity of milk of lime, to occasion an alkaline reaction. The sewage thus treated would be oxidised in its passage along seven miles of conduit, and at the outlet of the conduit it would be passed into receiving tanks. The deposited matter he would remove, and place upon the Corporation farm, ploughing it into the sandy soil, to prevent nuisance, and the effluent water might be turned at once into the river without danger, or, for the sake of greater security, might be passed through the land to be purchased. From the receiving tanks pipes of distribution might be sent off in various directions, but more particularly to about 1,000 acres of land lying between Whitacre and Kingsbury. The plan thus advised would, Mr. Hawksley states, command at least 6,000 acres of land by gravitation, and much more by moderate pumping lifts, to be established when a sufficient demand for the agricultural use of the sewage should arise. He is of opinion, however, that only a comparatively small quantity of sewage would remain to be put upon the acquired land, a large proportion being likely to be used by farmers along the line of the proposed conduit, the land below the conduit level being of a character well

Summary

suited for sewage irrigation. Mr. Hawksley further approves of the proposals to keep manufacturing refuse out of the sewers, and to abolish the midden system—the alternative to this being the general substitution of water-closets, which, as he observes, would increase the difficulty of the sewage problem in an incalculable degree, both as regards volume and cost of the treatment.

Acting upon these reports, and the other information obtained by them, the Sewage Inquiry Committee therefore, as previously stated, recommend the treatment of the sewage of Birmingham by the system of Downward Intermittent Filtration, for the purpose of purification; and for this purpose they are of opinion that 800 acres of land, with the 140 acres at Saltley, will be sufficient. The Borough will thus satisfy the requirements of the injunctions now issued against it, and avoid the enormous expense entailed by speculative experiments upon a scale of incalculable magnitude.

The cost of the proposed works and purchase of land is estimated at £324,000; the annual expenditure, for payment of interest and part repayment of capital, at £14,160; and the annual income at £9,200; leaving an estimated annual loss of £4,960. The Committee propose to obtain borrowing powers for the purchase of land and the execution of necessary works, providing for the former by a system of perpetual annuities, and spreading the repayment for works over a period of 75 years. They further propose to obtain powers for leasing lands and supplying sewage to occupiers and owners; and powers to exclude manufacturing refuse from the sewers. They recommend that, if possible, with Government co-operation, a Drainage Commission should be formed, elected by ratepayers of the whole district draining into the River Tame, and therefore polluting it with sewage. Finally, they recommend that, if their report is approved, the execution of its proposals shall be entrusted to a new Committee, to be called the Sanitary and Sewage Committee.

Summary

From this summary it will be seen that the recommendations of the Committee are directed towards effecting two main objects—(1) the exclusion of polluting matters from the sewers; and (2) the subsequent purification of the sewage by application to land. The first of these objects is to be secured by preventing manufacturing and other refuse of a deleterious nature from passing into the sewers; and by preventing the sewer drainage of middens, and consequently keeping out a large portion of the excreta of more than 320,000 persons in a total population of 345,000. Combined with this necessary exclusion is a system of improved privies and ashpits, disconnected from the sewers, and cut off from all contact with the sources of water supply; and thus, by the abolition of the midden system—already condemned by all sanitary authorities—the health and cleanliness of the town will be promoted in a most important degree. The second object, the purification of the sewage, so as to avoid the creation of a nuisance by the pollution of rivers and the deposition of offensive solid matter—is to be effected by excluding the sewage altogether from the River Tame, at Saltley, carrying it a distance of seven miles to suitable land, and there cleansing it, on a limited area, by the system of downward intermittent filtration, so that the effluent water may be safely passed into the river; provision being also made for the use of sewage by agriculturists along the line of conduit, and a small model sewage farm being established to instruct the neighbouring farmers in the use and value of sewage as a manure.

REPORT.

INTRODUCTION.

The Sewage Inquiry Committee was appointed by resolution (No. 7,777) of the Council of the Borough of Birmingham, on the 6th July, 1871, viz:— REPORT.

Resolved—

"That considering the great importance of the question of the disposal of the sewage of the Borough, so as to avoid the pollution of the neighbouring rivers and streams, or otherwise create a nuisance, and the desirability, if possible, of obtaining for any scheme in relation thereto the unanimous consent of the Council and the confidence of the Burgesses, and in order that the Council may deal with the subject promptly and to the satisfaction of the Court of Chancery, a Special Committee be, and is hereby appointed, consisting of Appointment of Committee.

Alderman AVERY,
„ HAWKES,
Councillor ALFRED BARRATT, M.D.,
„ CHAMBERLAIN,
„ JESSE COLLINGS,
„ HARRIS,
„ LOWE, and
„ EDMUND TONKS, B.C.L.

for the purpose of reporting to the Council as early as practicable, their opinion as to the best mode of disposing of, or dealing with, the sewage of the borough, with power to engage such professional assistance as they may deem necessary, and specially to consider if it be possible effectually to exclude from the sewers all excreta and other animal and Instructions to Committee.

injurious matters that tend to cause the sewage, as now discharged, to become a common nuisance, together with an estimate of the cost of carrying into effect any proposition which they may submit to the Council; and that the consideration of the Report of the Public Works Committee, now before the Council, be deferred until such Committee has reported."

The Committee thus appointed have now, in conformity with the instructions of the Council, to submit their Report.

They have to express their regret that Mr. Councillor Chamberlain, as he intimated would be the case when the above resolution was carried, has been hitherto unable to serve on the Committee.

Appointment of Officers.

At their first meeting, Mr. Alderman Avery was elected Chairman; and at a subsequent meeting Mr. G. S. Mathews, M.A., was appointed Secretary to the Committee, it being considered that the work devolving upon them rendered the services of such an officer necessary, the ordinary staff of the Town Clerk's office being too fully occupied to undertake the considerable labour required.

Since the date of their appointment, the Committee have given unremitting attention to the subject referred to them, in its various branches—sanitary, practical, and economic.

Work of the Committee.

The Committee have held 19 meetings, exclusive of meetings of various Sub-committees, and exclusive of deputations to some of the most important towns in the kingdom, for the purpose of conferring with their respective authorities, and investigating the latest development of the question therein. They have further supplemented personal investigations with information collected from various sources, viz., the Reports of the Rivers Pollution Commissioners, the Reports of the Medical Department of the Privy Council, the Reports of the British Association, and other trustworthy published works. The information thus obtained is embodied in this report, not only with the view of substantiating the conclusions of the Committee, but also to give the Council materials to form conclusions of their own, by laying before them a distinct conception of the magnitude and the nature of the difficulties to be encountered, and the various ways in which these difficulties have been elsewhere dealt with.

Scope of the Inquiry.

The chief subjects involved in a discussion of the Sewage Question are as follow :—

The Water Supply.—The strength of the sewage at the outfall mainly depends upon the amount of the water supply, for where subsoil water is kept out of the sewers, the volume of sewage daily discharged in dry weather may be approximately taken as the volume of water daily supplied. Moreover, where that supply

is derived from surface wells, a sanitary question of serious importance is also involved. Scope of the Inquiry.

The Disposal of Human Excreta.—On this subject the Committee were especially instructed to report, and they have, therefore, given it careful consideration. Excretal matters form a great part of the sewage proper, and their disposal involves a sanitary question similar to the one above alluded to.

The Disposal of Solid Refuse and Ashes.—In a large town this is generally a matter of great expense and difficulty, and is directly involved in the previous subject, because, under the midden system, the ashes and other house refuse and excretal matters are invariably mixed up and disposed of together.

The Ventilation, Trapping, and Flushing of Sewers.—This is obviously an important subject for consideration, because accumulations of filth in the sewers, and emanations arising therefrom, must be prejudicial to the health and comfort of the inhabitants.

Liquid Refuse from Manufactories.—A knowledge of the quantity and character of manufacturing refuse discharged into the sewers is also necessary, because the character of the sewage at the outfall may be seriously affected thereby.

The Disposal of Storm and Surface Water.—This water entering the sewers renders the volume so fluctuating (sometimes increasing the ordinary dry weather flow 4 or 5 times), that it most seriously augments the difficulty of dealing with the sewage at the outfall.

The Disposal of the Sewage at the Outfall constitutes the last and most important point of this inquiry; and this will be reserved for special consideration in another part of the Report.

PART I.

EXCLUSION OF EXCRETA FROM SEWERS.

In discussing the questions above described, it is desirable first to explain how they are dealt with in our own town; then, for the sake of comparison, to give the result of investigations thereon in the various towns from which information has been obtained; and, finally, the conclusions to which the Committee have been led thereby.

BIRMINGHAM.

Inquiry in Birmingham

The population of the Borough of Birmingham is 345,000, its area 8,420 acres, of which 5,870 are built upon, and the remaining 2,550 are still under cultivation. The number of houses in the borough is about 73,200, giving an average of 59 persons to an acre on the area built upon, and nearly 4·7 to every house.

Drainage of the Boroug

The whole of the borough is drained to one outfall at Saltley, with the exception of a small part—the Small Heath district—which is drained into a tributary of the river Cole. Upon this latter the Committee were not instructed to report, but they may here remark that the area of this district of the borough having a natural fall to the river Cole is about 930 acres, of which 750 acres are at present under cultivation. The remainder, built upon, contains 1,136 houses, which, upon the average scale of 4·7 persons per house, would give a population of 5,340. The ordinary dry weather flow of the sewage of this district is 214,000 gallons daily.

Water-closets and Ashpits.

Having been specially instructed to report upon the possibility of excluding excreta from the sewers, it was of course necessary to ascertain accurately how these matters are actually disposed of, and for this purpose the Borough Surveyor was instructed to make a return of the number of water-closets and ashpits, drained and undrained.

Borough Surveyors' Return.

This return will be found in Appendix I., and contains a detailed account of the number of houses, manufactories, public buildings, stables, cowhouses, slaughter-houses, water-closets, and ashpits, drained and undrained, for every street in the borough, with a summary of the whole, and a distinct summary for the district draining into the river Cole, viz. :—

	River Tame District.		River Cole District.		Total.
No. of Houses	72,087	—	1,136	—	73,223
" Manufactories, workshops, &c.	6,835	—	44	—	6,879
" Public buildings	282	—	3	—	285
" Stables	3,203	—	111	—	3,314
" Cowhouses	154	—	13	—	167
" Slaughter-houses	292	—	3	—	295
" Communications with sewers	12,970	—	310	—	13,280
" Premises with W.C.'s draining into sewers	3,829	—	55	—	3,884
" Water-closets	7,005	—	60	—	7,065
" Ashpits draining into sewers	13,534	—	458	—	13,992
" Ashpits undrained	5,469	—	90	—	5,559
" Covered Ashpits included in the two previous items	4,233	—	45	—	4,278

An analysis of this return shows that in Edgbaston Ward alone there are 1,136 premises, containing 1,658 water-closets, or about one-third of the total number.

Rateable values of Houses, &c.

It was further thought expedient to obtain information as to the relative net rateable values of the houses in the borough, and the Superintendent of the Rate Department has accordingly furnished the following report :—

Ratable Values.

HOUSES ONLY.

62,365	rated		under £20.
3,121	„	over £20 and	„ £50.
729	„	„ £50	„ £100.
242	„	„ £100.	

HOUSES WITH OTHER BUILDINGS.

1,762	rated		under £20.
2,477	„	over £20 and	„ £50.
1,006	„	„ £50	„ £100.
748	„	„ £100.	

It appears that there are 3,884 premises, containing 7,065 water-closets, in the borough, and about 70,000 houses connected with 19,551 middens, drained and undrained.

The Midden system.

The proportion of middens to water-closets has never before been accurately ascertained; in fact, in the first Report of the Rivers Pollution Commission, Birmingham is classed as a water-closet town, and therefore the actual enormous preponderance of middens is a matter of some surprise.

The above figures require a little further consideration in order to appreciate their full significance.

Middens and water-closets in proporton to population.

It is necessary to ascertain not only the actual number of water-closets and middens, but the actual proportions of the population respectively using them. Water-closets are, as a rule, used by the richer, middens by the poorer class, and, as may be expected, the accommodation for the former is greatly in excess of the accommodation for the latter. Thus, the number of premises with water-closets is 3,884, the number of water-closets 7,005, or nearly two water-closets to each building. Assuming these buildings to be all dwelling houses, and assuming 5, instead of 4·7, dwellers in each house, the fullest estimate of the number of persons using water-closets, and thereby discharging the solid as well as liquid excreta into the sewers, is 19,420, leaving a population of about 325,000 whose excreta are discharged into 19,551 middens, drained and undrained.

Sanitary effect of Middens, &c.

It will be useful to consider what this actually implies, *i.e.*, what the midden system is which is so greatly developed in this, and, in fact, in most other towns.

In the populous parts of towns, where every yard of land is valuable, and made available for the erection of small houses, it naturally happens that the privy accommodation is not usually placed where from sanitary considerations it should be, but wherever room can be found, regardless of the health, convenience, or cleanliness of the inhabitants.

The ashpits or "middens" attached to the privies receive not only the fœcal matters, but all the solid, and often the liquid, refuse of the houses connected with them. They are sometimes

situated under, and are often built against, or even form part of the walls of, dwelling houses, which are thereby permeated with the gases arising from the middens, or rendered damp with the filthy liquid soaking through their walls.

The greater number are uncovered, and, whether drained into the sewers or undrained, their contents too frequently become a stagnant semifluid mass of decomposing matter.

Pollution of wells.

The wells, where there are any, are polluted by soakage into them, and their water rendered unfit for domestic purposes, and the air, which in these crowded districts is necessarily impure, is further charged with offensive emanations.

It is generally admitted that surroundings of this character must not only affect the general sanitary condition of the people, but must also tend to retard the developement of habits of cleanliness and decency, so essential to their well-being.

Finally, these receptacles are emptied at most two or three times a year, either by notice to the Night Soil Department, by owners or occupiers, or, as very frequently happens, by order of the Inspector of Nuisances, when their offensive condition attracts his notice.

The figures already given sufficiently show how universal the midden system is in Birmingham. It is now desirable to see how the actual effects harmonise with the above general statement.

Report of Inspector of Nuisances.

With reference to the situation of middens, and the manner in which they are emptied, the Inspector of Nuisances has furnished the following report:—

"Borough of Birmingham,
"Office of Inspector of Nuisances,
"July 31st, 1871.

"To the Sewage Inquiry Committee.

"Gentlemen,—

"In reply to your resolution No. 22, I have to report that the ashpits in this borough are not emptied by any regular periodical system, but are emptied when application is made by the occupiers or owners of the premises where they are situated, or by orders from the Inspectors of Nuisances, when in their visitations they find the ashpits require emptying; or, if the night-men have not sufficient orders from the office, they are instructed to empty any they may find full. In some cases ashpits are twelve months, or even longer, from the time they are emptied till they again become full, in other instances six or three months, depending upon the number of occupiers of houses depositing their refuse in the same place, or on the size of the ashpit.

"The privies and ashpits are in many instances in a very bad condition. In some streets that are not sewered, the ashpits (even

when covered) contain liquid filth; in streets that are sewered, where the ashpits are mostly drained, the drains get choked, the ashpits fill, and then, as frequently happens, become very offensive (in spite of all the attention paid by the Inspectors who from time to time visit them). Moreover, from their close proximity to wells, it is certain the liquid must percolate through the earth, and so render the well water unfit for domestic use. In many cases privies and ashpits are erected against the walls of dwelling houses, causing them to be damp, and at times the liquid soaks through the walls into the houses; in other instances workshops are erected over privies and ashpits, which render the shops unfit for people to work in; and, at this season of the year especially, large quantities of vegetable matter are thrown into the ashpits, decomposing and giving off very offensive effluvia; and, from my experience as Inspector of Nuisances, I have no doubt such places are a nuisance and injurious to health. Condition of Middens.

"I am,

"Gentlemen,

"Your obedient servant,

"ROBERT WOOLLEY."

The Inspector of Nuisances has also supplied the following information:—

"The fair average size of middens in Birmingham may be taken to be 6 feet in length, 5 in breadth, and 5ft. 6in. deep—3 feet below and 2½ feet above the surface of the ground." Size and number of Middens

The total number of middens is 19,551, and it would thus appear that the area occupied by these offensive receptacles is 65,170 square yards, or about 13½ acres.

Moreover, 4,278 are covered, a few by a simple roof, some by being actually built into dwelling houses, but by far the greater number by the erection of workshops over them, and only separated therefrom by a boarded floor.

It has now to be shown how the midden system actually affects the well water, which in Birmingham is very largely used for domestic purposes, especially by the poorer class of the population. Effect of Middens upon Water Supply.

It has been estimated that between three-fifths and three-fourths of the inhabitants of the borough are supplied with water for domestic purposes by the Birmingham Waterworks Company, at about 35 gallons a head.

Assuming that 240,000 people are thus supplied, there remains a population of 105,000 entirely supplied with water from surface wells.

The character of this water may be inferred from the following table, which is extracted from the paper read by the Borough Analysis of Water Supply.

Analysis of Water Supply.

Analyst at the Social Science Congress held in this town in 1868, and is the result of numerous analyses of the well water made by him.

The analysis of water supplied by the Waterworks Company from their well at Aston, is first given for the sake of comparison.

	Total solid matter in grains per gallon.	Volatile and combustible matter.	Chloride of Sodium.	Nitric Acid.	Degrees of Hardness before boiling	Degrees of Hardness after boiling.
ASTON BORE HOLE	12.88	0.84	0.91	None.	9.3	...
3 COURT, DALE END	85.12	10.36	24.96	Very much	...	...
1 COURT, INGE STREET	109.76	19.60	33.55	,,	...	...
17 COURT, ALLISON STREET	301.56	13.44	51.15	,,	...	...
BACK OF OLD GATE, SMALL HEATH ...	101.64	11.42	18.41	,,	38.25	...
GROCOTT'S BUILDINGS, GARRISON LANE	256.48	21.00	44.19	,,	93.0	...
BURBURY STREET	65.80	15.96	19.43	,,	16.0	...
BACK OF 31, KING EDWARD'S ROAD ...	58.80	10.08	16.77	,,	21.8	...
32 COURT, LATIMER STREET	66.92	16.80	18.41	,,	...	...
177, IRVING STREET	75.60	12.32	16.77	,,	...	...
153, BREARLEY STREET	95.76	18.76	20.46	,,	...	...
3 COURT, LENCH STREET, Feb. 1868 ...	73.22	12.53	16.37	,,	30.0	20.6
8 COURT, LENCH STREET, ,, ...	138.67	23.87	30.28	,,	45.0	24.0
	Evaporated residue acid and very dirty.					
2 COURT, BRICKKILN STREET, ,, ...	190.54	26.53	53.19	,,	66.0	50.0
	Becomes dirty on being simply boiled.					
16 COURT, STANIFORTH STREET ,, ...	209.44	28.77	54.42	enorm. quantity.	59.0	50.0
4 COURT, CANAL STREET, ,, ..	129.92	8.54	45.83	Very much	33.6	27.0
8 COURT, PRINCIP STREET, ,, ...	130.83	11.62	67.93	,,	50.0	39.0
BIRMINGHAM	48.30	3.08	9.80	14.42	24.6	...
Ditto (Constitution Hill)	84.00	12.60	28.64	Much.	...	...
Ditto	85.68	11.90	39.72	13.09	48.0	...
Ditto	121.80	11.20	24.13	30.43	44.0	...
Ditto (New Market Street)	148.26	18.48	32.33	24.05	46.0	...
Ditto (New Summer Street)	186.90	8.40	53.16	Much.	...	...
Ditto	212.80	22.12	49.10	,,	60.0	...
Ditto (Dean Street)	380.24	39.20	17.41	...	...	...
Ditto ditto	507.92	48.16	16.37	Much	Protosalt of Iron	
DUCHESS ROAD, EDGBASTON, Feb., 1868	113.40	12.04	19.23	...	66.5	54.0

Opinions of the Medical Profession.

It might seem superfluous to make any inquiry into the sanitary effect of this general pollution of earth, air, and water, arising from the midden system, or of the gases arising from the decomposition of fœcal matter discharged into the sewers from water-closets. There is, at any rate, sufficient general medical testimony on this subject; but still the Committee thought it might be useful to elicit an expression of opinion from the leading Physicians and Surgeons and Parochial Medical Officers of the Borough, to whom they accordingly addressed a series of questions. The letter of the Committee, with the answers received, will be found in Appendix II.; but the opinions contained therein may be thus briefly summarised.

There appears to be a unanimous opinion on the following points:—

1. That the pollution of well water by sewage matter is general, and the use of such water most dangerous to health.

2. That sewer gases arising from the decomposition of fœcal matter do penetrate through house drains into the interior of dwellings, and that their effect is dangerous to health.

3. That emanations from middens are also highly dangerous.

4. That fevers of a typhoid character, diseases of the digestive organs, diarrhœa, and diseases of a similar character, besides others, are directly traceable to the above causes, and that the same causes greatly increase the susceptibility to all epidemic diseases.

Suggestion of Remedies.

The various replies contain, among others, the following suggestions for remedying the sanitary evils attributed to the present sewage system:—

(a) Appointment of a Medical Officer of Health.

(b) Better system of ventilation and flushing of sewers.

(c) Cutting off the continuous pipe connection between sewers and house drains.

(d) The closing of all wells.

(e) The improvement of middens.

(f) The use of disinfectants.

(g) The interception of fœcal matter.

Objection to extension of water-closet system.

From a consideration of the facts and opinions above quoted, it appeared to the Committee that some radical alteration in the midden system was absolutely necessary. The sanitary improvements required could be effected either by the conversion of existing middens into water-closets, which, as will presently be seen, has been already done in Liverpool; or into some improved privy system which, as will also be shown, is being rapidly effected in Manchester, Rochdale, and other towns. But apart from sanitary considerations, the extension of the water-closet system involves difficulties of the gravest character. It implies in the first place structural alterations of much greater cost than would be necessary in the conversion of existing middens to privies upon any of the new systems now being introduced. It implies also the necessity for a largely increased water supply, and a corresponding increase of water rate, and finally it implies an enormous increase in the volume to be dealt with at the outfall, the purification of which is even now quite out of the range of existing experience, and which the Committee are most anxious to lessen, rather than increase.

Official Inquiry by Medical Officer of Privy Council.

The Committee being of opinion that an Official Report from an authoritative source would greatly strengthen the action of the Council in effecting any alteration in the existing midden system, considered it expedient to obtain such a report with the least possible delay from the Medical Department of the Privy Council.

They therefore applied to the Lords of Her Majesty's Privy Council for this purpose, and their Lordships have accordingly directed an inspection of the sanitary condition of Birmingham, which will be undertaken as soon as the state of business in the Medical Department will permit.

The correspondence on this matter will be found in Appendix III.

The Committee regret that they are compelled to report before this inspection has been made, but they may state, as the result of personal observation, that the condition of Birmingham at the present time in this respect must be at least as bad as is described in the following extract from a report by Dr. Buchanan and Mr. J. Netten Radcliffe, contained the 12th Report of the Medical Officer of Privy Council, published in 1870 :—

Privy Council Report for 1870.

"In Birmingham only one lesson was learnt from the present inspection, viz., that a town may have the worst possible arrangements for dealing with its excrement, and yet have a credit for healthiness, and indeed, not have the very highest of all possible death-rates. It appeared to us, from our somewhat cursory experience, that the probable reason why more mischief does not accrue from the immense store of decomposing filth within the town, was that, as a rule, the streets and houses had much open space about them. Except in better-class houses the whole excrement disposal is on the midden system. There are no bye-laws regulating the construction of privies or ashpits in new houses, but plans of new buildings and their belongings have to be approved by the Borough Surveyor, who requires that each privy pit shall be provided with drains; but for the rest, a builder may build houses and privies on any plan that suits him, without much interference from the authorities. There appears, therefore, no prospect of rapid improvement on the filthy state of things that exists throughout the poorer parts of the town. At present it is common to find huge, wet, fœtid middens uncovered, undrained, unemptied, some of them as deep and big as the foundations of an ordinary cottage. Few of them are covered, the Inspector of Nuisances thinking they are better left open. Many are under workshops, where work is done amid stench all the year round, and among swarms of flies in the summer. Of course the middens attached to particular houses are commonly better kept; but, to a very large extent, in the poorer quarters of the town the privies are of such construction as this, and being common to several houses, and without any efficient supervision, they are usually found abominably offensive. The Corporation undertakes the removal of the contents of middens."

The Death Rate.

The low death rate of Birmingham has been often quoted as a proof of its general satisfactory sanitary arrangements, but in reality no argument can be more fallacious.

Comparison of Wards.

It is impossible to arrive at any reasonable comparison of the sanitary condition of different towns by a simple comparison of

their death rates, because the death rate depends as much, or more, upon local as upon general conditions, and the local conditions of Birmingham are peculiarly favourable.

It is idle to congratulate ourselves on a low death rate while at the same time it is possible to point to a number of diseases usually attributed to preventible causes, and it is these preventible causes which it is one of the duties of the Committee to investigate.

Registrar-General's Returns.

Although, however, the argument drawn from a comparison of the death rates of different towns is fallacious, that argument may be reasonably applied to separate parts of the same town, because many of the local conditions may be taken as the same; so if we compare the different wards of Birmingham it will at once appear that in some the death rate is relatively and absolutely excessive. This is evident from the Registrar's return for the quarter ending June 30th, 1871 :—

Cities and Boroughs.	Population. Estimated population in the middle of year 1871.	Births. Registered in 13 weeks, ending July 1, 1871.	Births. Annual rate per 1,000 in same period.	Deaths. Registered in 13 weeks, ending July 1, 1871.	Deaths. Annual rate per 1,000 in same period.	Death Rate. Average annual rate of mortality to 1000 persons in 10 years 1861-70.
Columns—	1	2	3	4	5	6
London (Regis.-Gen.) ...	3,263,872	27,290	33·6	18,815	23·1	24·3
Liverpool (borough)	494,649	4,453	36·1	4,130	33·5	33·5
Manchester (city)	356,089	3,527	39·8	2,489	28·1	30·2
Salford (borough)	125,422	1,298	41·5	907	29·0	27·0
BIRMINGHAM (borough)	344,980	3,248	37·8	1,993	23·2	24·8
Leeds (borough)	260,657	2,637	40·6	1,509	23·2	28·0
Sheffield (borough)	241,507	2,471	41·1	1,513	25·1	27·2
Bristol (city)	183,298	1,565	34·3	870	19·1	22·5
Newcastle-on-Tyne (bor.)...	128,677	1,284	40·0	1,040	32·4	28·2
Hull (borough)	122,266	1,133	37·2	660	21·7	24·9
Bradford (borough)	146,987	1,446	39·5	905	24·7	26·2
(Regis. Sub-districts in Birmingham)						
1. Ladywood *	42,998	405	37·8	204	19·0	21·2
2. St. Thomas†	33,858	304	36·0	191	22·6	25·1
3. St. Martin	30,864	291	37·8	174	22·6	24·1
4. St. Peter	13,204	133	40·3	72	21·8	26·0
5. St. Philip	7,743	71	36·9	43	22·3	21·5
6. St. Paul	7,344	35	19·1	33	18·0	23·8
7. St. Mary	15,875	122	30·9	88	22·3	28·7
8. St. George ‡...	49,628	500	40·4	362	29·3	28·8
9. All Saints §	29,920	297	39·9	285	38·3	37·1
10. Deritend	49,800	530	42·7	241	19·4	21·4
11. Duddeston	46,176	466	40·5	234	20·3	22·6
12. Edgbaston	17,570	94	21·5	66	15·1	13·8

* Contains the Children's Hospital.
† Contains the Queen's Hospital.
‡ Contains the General Hospital.
§ Contains the Workhouse and Lunatic Asylum.

System of cleansing Middens, &c.

The "night soil," or the contents of middens, are thus disposed of. The middens are first emptied, at night, into the street. This in itself creates a formidable nuisance, which it would be expedient if possible to avoid. A small proportion is directly removed by farmers for manure, but by far the greater part is carted to the various wharves in the occupation of the Corporation, viz., Holliday Street, Coventry Road, Great Barr Street, and Shadwell Street, and canal boats returning empty from Birmingham are filled for 23s. per boat. A small portion is also sent away to the country, from a siding on the Midland Railway at Lawley Street.

There is, however, always a certain portion which it is impossible to get rid of in this manner, *i.e.*, the drier ashes and rubbish which has no manurial value. This is taken outside the town by canal, to a spot where the canal is on an embankment, and it is there tipped into an adjoining field.

Disposal of Street Sweepings.

But the greatest difficulty connected with the Scavenging Department is that of disposing of the road detritus, or street sweepings.

Birmingham is a macadamised and not a paved town, and the consequence is an immense amount of road detritus; the greater part of this is swept up and carted away, but in wet weather a portion is washed through the street gulleys into the sewers, and so carried to the outfall at Saltley, and constitutes, on a rough estimate, about one-half of the total quantity of 120 tons per day of solid matter there deposited.

Various gulley-traps have been tried with a view of excluding this from the sewers, but as the Borough Surveyor is of opinion [see report on this point in Appendix IV.] that those now in use are as efficient as possible, there is little hope that the quantity can be materially diminished with the present system of macadamised roads.

Value of Street Sweepings.

In the streets of a paved town, at any rate where there is considerable traffic, the street sweepings contain so large a proportion of vegetable refuse and horse-droppings that they have considerable manurial value, and can readily be disposed of. This is not the case in a macadamised town like Birmingham. The road detritus is so great that the sweepings have little manurial value, and it is, in fact, impossible even to give them away. They are consequently carted away, and tipped on any available spot; the principal tipping grounds being, at present, Curzon Street, King Edward's Road, Garrison Street, and Leopold Street. Room for this deposit is becoming a matter of serious and increasing difficulty.

Cost of Night Soil Department.

The total cost of the Night Soil Department for the year ending December 31, 1870, amounted to	£11,927
Receipts	5,660
Showing a net cost of	£6,267

Storm Water in the Sewers.

The storm water is taken into the sewers; and although a great portion of this passes off into the river at the various bridges, by openings in the sewers, which allow the water to pass out when it rises to a certain height, nevertheless the fluctuation in the character and volume of the sewage at the outfall from this cause is so great that it constitutes one of the greatest difficulties in dealing with it.

The contents of several old water-courses which had become polluted have also been turned into the sewers.

Cost of the Sewers.

If these, together with the storm and surface water, could be absolutely excluded and conveyed separately to the river, the difficulty of dealing with the sewage at the outfall would be materially diminished. To effect this perfectly would involve a complete system of double drainage. In the meantime we have to make the best of our present system, which has been developed at a cost of £250,000. How far it might be possible partially to effect the exclusion by supplementary drains in particular districts, is a question to which reference will be made in the second part of this Report.

Refuse from Manufactories &c.

In addition to the fœcal matters from water-closets, drained middens, and urinals; chamber and kitchen slops, and liquid refuse from stables, cowhouses, slaughter-houses, and various manufactories of the town are also discharged into the sewers.

Pollution of Sewage thereby.

As the liquid waste of some manufactories pollutes the sewage, not only by rendering it unfit for discharge into the river, but also by rendering it injurious to vegetation, it appeared expedient to make a special investigation into the amount as well as the nature of those liquid wastes which appeared to be the most injurious, with a view of considering whether it would be possible or expedient to exclude any such from the sewers.

Trades selected.

For this purpose the Committee selected the following—brassfounders, galvanisers, manufacturing chemists, wire drawers, and German silver manufacturers, and instructed the Borough Surveyor to determine the quantity, and take an average sample, of the liquid waste discharged from the works of some one of each of these manufacturers.

The report of the Borough Surveyor on this subject will be found in Appendix V.

Dr. Frankland's Report.

The samples so taken were forwarded to Dr. E. Frankland, of the Royal College of Chemistry, and one of the Rivers Pollution Commissioners, who has submitted thereon the following report:—

Royal College of Chemistry,
315, Oxford Street,
Sept. 16th, 1871.

The Chairman of the Birmingham Sewage Inquiry Committee.

Sir,—

In accordance with instructions contained in the Borough Surveyor's letter, dated August 16th, 1871, I have submitted to analysis and investigation the following special and average samples of sewage collected in Birmingham:—

1. Sewage from brassfounders.
2. Sewage from German silver manufacturers.
3. Sewage from manufacturing chemists.
4. Sewage from galvanising works.
5. Sewage from wire manufacturers.

These analyses are not yet complete, but they are sufficiently so to enable me to report upon—1st, the influence of these discharges upon the general sewage of Birmingham; and, 2nd, their effect on vegetation, if the town sewage were utilised upon an irrigation farm.

RESULTS OF ANALYSIS EXPRESSED IN PARTS PER 100,000.

1. Sewage from Brassfounders.

Matters in suspension—	
Mineral	11·28
Organic	3·92
Total	15·20
Matters in solution	55·70

This sewage is neutral to test papers, and contains chiefly salts of lime and magnesia, with traces only of iron and zinc.

2. Sewage from German Silver Manufacturers.

Matters in suspension—	
Mineral	32·12
Organic	8·28
Total	40.40
Matters in solution	1613·0

Dr. Frankland's Report.

Besides a considerable proportion of salts of lime, magnesia, and soda, which are of no importance to the question at issue, 100,000lbs. of this sewage contain 445·06 parts of iron, as protosulphate and protochloride of iron. This sewage is acid to an extent which would be produced by the addition of oil of vitriol to water, in such proportion that 100,000lbs. of the mixture would contain 751·4lbs. of oil of vitriol.

3. Sewage from Manufacturing Chemists.

Matters in suspension—	
Mineral	21·6
Organic	47·0
Total	68·6
Total matters in solution	1249·0

This sewage is alkaline to test paper, and contains a considerable quantity of carbolic acid and oil of tar, together with salts of iron, lime, and magnesia, with traces of zinc.

4. Sewage from Galvanising Works.

Matters in suspension—	
Mineral	17·76
Organic	16·28
Total	34·04
Total matters in solution	1986·0

This sewage contains salts of zinc, lime, and magnesia; and 100,000lbs. of it contain 698·8lbs. of iron in the condition of protosulphate and protochloride. It has an acidity equal to that produced by the addition of 1,784·5lbs. of sulphuric acid to 98,215lbs. of water.

5. Sewage from Wire Manufacturers.

Matters in suspension—	
Mineral	132·52
Organic	35·56
Total	168·08
Total matters in solution	1009·4

100,000lbs. of this sewage contain 218·7lbs. of iron, as protosulphate and protochloride. It is neutral to test paper.

The Effect of the above Manufacturing Discharges upon the General Sewage of Birmingham.

It may be stated in general terms that none of these refuse liquids contribute in any important degree to the manurial value of

Dr. Frankland's Report.

the sewage, but the liquids discharged from the works of German silver manufacturers, manufacturing chemists, galvanising works, and wire manufacturers contribute to protect the sewage from putrefaction during its flow through the sewers and conduits; this protecting influence ceases, however, when the sewage is discharged into a comparatively large volume of running water. Such being the case, and as sewage not so protected does not enter into putrefaction during its flow through properly constructed sewers, I consider the addition of such protecting liquids to be practically valueless. Although the analyses made by Dr. Vœlcker and Dr. Hill show average samples of the general sewage of Birmingham to be neutral, yet as the discharges from the above-mentioned factories are almost necessarily sudden and intermittent, it can scarcely be doubted that such of them as are of an acid character will, to some extent, damage the brick-work of the sewers into which they are discharged.

The sewage from brassfounders being neutral, and containing but mere traces of the antiseptic salts of iron and zinc, its admission into the sewers of the town would exercise no appreciable influence either upon the brick-work or upon the sewage itself.

Effect of the above Manufacturing Discharges upon Vegetation, if the Town Sewage were used upon an Irrigation Farm.

The constituents contained in the above discharges which alone need be regarded as inimical to vegetation are—1st, salts of iron; and, 2nd, carbolic acid and oil of tar.

The influence which these deleterious constituents would exert upon vegetation, if the sewage were used for irrigation, would probably not be very serious if the liquids in which they occur were discharged uniformly throughout the working hours of the day. But as such manufacturing discharges are usually made in gushes at irregular intervals, it would be necessary, in order to avoid the evil consequences thereof, to make arrangements for the sotrage of 24 hours-sewage before its application to the land, and if to the sewage so stored there were added the proportion of quicklime recommended by Dr. Hill, all danger to the crops would be entirely avoided. I cannot, however, recommend either the storage or the treatment with lime of such a vast volume of sewage as that of Birmingham. The additional expense to which the borough would be put by such storage and treatment would doubtless be far greater than that which would arise to manufacturers from a prohibition to discharge such noxious liquids into the sewers, whilst the risk to health would not be inconsiderable.

I am therefore of opinion that powers ought to be sought to enable you to prevent the discharge into the town sewers of pickling or ferruginous liquids, such as those you have collected from the works of German silver manufacturers, galvanisers, and wire manufacturers. The discharge of carbolic acid and similar products derived from wood or coal-tar should also be interdicted. There is no necessity for the casting of any of these liquids, noxious to vegetation, into the sewers; the pickling and ferruginous liquids can be converted into marketable salts, which will nearly, if not

quite, repay the cost of their manufacture, whilst the carbolic acid and other tar products can be readily disposed of by being evaporated in the ashpits of any furnaces which may be used in the factories where such products require to be got rid of.

I am, Sir,

Your obedient servant,

E. FRANKLAND.

The sewers are ventilated simply by openings in the streets, and they are principally flushed by storms.

Works at the Sewers Outlet.

The discharge at the Saltley outfall, amounting to an ordinary dry weather flow of 17 million gallons daily, is dealt with in the following manner:—The works consist of two complete sets of a series of simple subsiding tanks, by passing through which a great portion of the suspended matter is deposited. The sewage is turned into one set, and in about 14 days this is filled up with the deposited matters; the sewage is then turned into the other set, and the deposited matter in the former is removed.

The matter deposited in the first tank of each series is composed of the heavier portions of road detritus and coarser suspended matters; it is dried simply by the draining of the tank, and is then easily barrowed out. The road silt is separated as far as practicable, and is used for mending the farm roads, or otherwise got rid of. The rest is a good manure, and in a fit state to be at once carted away. It is sold at about 1s. to 1s. 6d. per cart-load, and there is no difficulty in disposing of it.

The rest of the deposited matter, in the form of a black slush, of which a large proportion consists of the finer road silt, is chiefly deposited in the other tanks of the series. It is removed from the tanks by buckets on an endless chain, worked by steam power, and is run upon the adjoining land in large beds to dry, a process which occupies about nine months. It is then sold for manure, at £1 per boat-load—about 27 tons—loaded at the expense of the Corporation.

Nuisances at Outlet.

The effluent water passing into the river Tame pollutes it, and has given rise to the injunction obtained by the Right Hon. Sir C. B. Adderley, M.P.

The nuisance arising from the drying of the deposited slush has given rise to the injunction obtained by the inhabitants of Gravelly Hill.

Sewage Farm at Saltley.

In order to complete this description, it should be added that in 1867 it was resolved to make an experiment on the utilisation of

Birmingham sewage by irrigation, and land was accordingly taken in the neighbourhood of the Saltley outfall for this purpose, as under:

			£	s.	d.
14	acres	belonging to the Corporation	—	—	—
109	„	belonging to W. Hutton, Esq., on a 21 years lease, at £7 per acre - -	763	0	0
7½	„	belonging to Sir C. B. Adderley, on same terms, at £6 per acre - - -	45	0	0
12	„	belonging to Incumbent of Water Orton Chapel, on a yearly tenancy, at a rent of - - - - - - - -	50	0	0
142½	acres		£858	0	0

The land is irrigated with raw sewage taken direct from the mains.

A portion only is drained, and that to an insufficient depth, so that for the most part the effluent water passes over instead of through the land.

Moreover, the land lies low and near the river, in a position which renders it liable to floods, and unfit for sewage irrigation.

The Committee have not been able to obtain information on the amount of sewage actually applied to the various crops grown; or on the number of, the duration of, and the intervals between the dressings, or any observations to determine in what amount, in what manner, and in what seasons such dressings of sewage can be most beneficially applied—in other words, the information which it was the object of the experiment to obtain.

A statement of the Income and Expenditure Account, and of the various crops grown and prices realised therefor, has been kindly supplied by the Public Works Committee, at the request of this Committee, and a statement has been obtained from the Borough Treasurer of the whole receipts and payments from the establishment of the farm to the present date.

These statements will be found in Appendix VI.

Cost of the Sewage Farm.

The Borough Treasurer's Report shows a total balance of payments over and above receipts of £9,728 18s. 9d., extending over a period of four years' occupation of a farm of 142 acres. The Report of the Public Works Committee shows a balance of payments over and above receipts, on the farming operations, of £3,466 1s. 10d.

The difference, amounting to about £6,263, comprises an expenditure of £1,096 in law and professional charges, and of about £5,167 in sundry wages, implements, materials, team hire, &c., which the Committee assume represents the expense of laying out the land for the reception of sewage.

It would appear from the Borough Treasurer's Report, that £5,635 has been transferred to capital account, in respect of which £5,000 has been borrowed at 4 per cent., to be repaid by a sinking fund in 20 years.

The amounts of principal repaid form part of the expenses included in the Income and Expenditure Account of the Public Works Committee.

CONDITION OF OTHER TOWNS.

Inquiries in other Towns.

The Committee now proceed to give a statement of the information they have obtained by personal investigation and correspondence with the towns of Liverpool, Bolton, Manchester, Rochdale, Leeds, Nottingham, and Hull.

LIVERPOOL.

LIVERPOOL.

With the exception of London, Liverpool is not only the most populous but the most densely populated town in England.

Its population is 493,000, the number of inhabited houses about 80,000, and its area 5,210 acres, giving an average of 95 people to an acre, and 6 to every house.

Powers of Council.

The midden system almost universally prevailed in the central, sickly, and crowded districts of Liverpool up to the passing of the Sanitary Amendment Act of 1854, which gave the Council the power, upon the certificate of the Medical Officer of Health, to compel owners to abate the nuisance of privies and middens, and provided that, "when it shall have been certified by the Medical Officer of Health that any privy or midden is in a condition, state, or situation injurious, dangerous, or prejudicial to the health of the inhabitants of the borough, the owner thereof may be required, within a reasonable time, and at his own expense, effectually to abate and remedy the same to the satisfaction of the Council."

In giving practical effect to these powers, it became necessary for the Council to lay down as accurately as possible the conditions which would justify the certificate of the Medical Officer of Health, and the structural alterations required.

Substitution of Water-closets for Privies.

On the latter point they were led to impose as complete as possible a substitution of water-closets for privies, not because they considered the water-closet system in itself the best mode of disposing of the sewage of a town, but because it seemed the best and simplest way of removing the excreta speedily and effectually, and because the local circumstances of Liverpool favoured this course,

LIVERPOOL. by enabling them to discharge the contents of the sewers at once into the Mersey, where they are immediately carried away by a volume of water so great, and a current so strong, that no silt is deposited and no nuisance created, at any rate in the vicinity of Liverpool itself.

Water Supply. Liverpool is supplied entirely by the Corporation with water for domestic purposes, at the rate of about 25 gallons per head daily. Part of this supply used to be derived from wells situated within the borough; but most of these are now entirely closed, in consequence of their contamination by sewage. It is now practically a complete water-closet town: there are about 50,000 water-closets; and two years ago there remained only 15,000 privies. No new privy is allowed to be erected; and within the last few years about 15,000 privies, with uncovered ashpits, have been converted into trough water-closets, the greater number under the certificate of the Medical Officer of Health, but many hundreds by the owners of their own free will, as they have found the change so much to their own advantage.

Water-closet System.

The Trough-closet. The trough water-closets (see Plates 1 and 2), which have been substituted for the open middens in the courts of Liverpool, are entirely under the control of the officers of the Corporation. The people using them have no power of turning on the water themselves; but the tap is kept under lock and key, and once a day the contents are well flushed into the sewers, and the courts washed clean by means of a hose and hydrant, by a special staff of Corporation officers appointed for this purpose.

Moveable Ashbins. The courts are also provided with movable ashbins, for the temporary reception of miscellaneous household solid refuse and cinders, and the kitchen and chamber slops are emptied into the sewers through properly trapped grids in front of the houses.

Cost of Scavenging. The cost of scavenging the town of Liverpool is excessive, and has been increased by the extension of the water-closet system, owing to the difficulty of disposing of the dry refuse and ashes.

The scavenging may be classed under three heads:—

Disposal of Night Soil, &c

1. *The contents of the remaining privy middens, or the night-soil.* These, speaking generally, are removed during the night in the usual way, and carted to the railway siding or one or other of the canal wharves belonging to the Corporation, and thence at once conveyed away and sold to farmers, or taken and deposited in the county depôts.

2. *The contents of the dry ashpits and dustbins.* These are collected in the daytime by the dust carts, and, together with the sweepings of macadamised roads, which are on the outskirts of the town and have no manurial value, are utilised

for filling up disused brickfields, quarries, and other vacant places; but any general rubbish which is too foul to be utilised in this manner is separated and removed, at the cost of the Corporation, to the country depôts, of which there are three, from seven to sixteen miles from Liverpool, and one of which is a farm of 80 acres, recently purchased by the Corporation for the deposit of this refuse. The difficulty of finding space for this purpose is so great that a proposition has been recently made to purchase a tract of land, 16,000 acres in extent, on the fore-shore of the Dee, at a distance of upwards of ten miles from Liverpool, and to convey the dry refuse there in barges for deposit. LIVERPOOL.

3. *The street sweepings of the town proper.* This is treated as night soil. Liverpool, like most towns in the same district, is for the most part paved, and not macadamised. There is, consequently, very little road detritus, and the street sweepings of the paved streets containing a large proportion of horse-droppings and vegetable refuse, have a considerable manurial value.

The night soil, with this refuse, after being deposited in the boats or railway wagons, is sold for about two shillings per ton. There is a good demand for it, and it is estimated that at least twice as much might readily be disposed of. Cost of Scavengering.

The total cost of the scavenging department for 1870, exclusive of all establishment charges, amounted to about	£19,700
The sales of manure to	7,500
Leaving a net cost of	£12,200

No expense or care seem to have been spared in perfecting the sewerage system of Liverpool, and the best known sanitary arrangements seem to have been adopted for the purpose of preventing the penetration of sewer gases into the interior of dwellings. Sewage System, Flushing, Ventilation, &c.

A better system of inspection of sewers is about to be organised. The system of flushing the house and court drains into the main sewers ensures the carrying away of all fœcal matter to the outfall with the greatest possible despatch.

The system of ventilation is three-fold.

First.—The sewers are connected by flues with the lofty chimneys of factories.

Secondly.—The down-spouts of high houses, when not near windows, are carried into the sewers without being trapped.

LIVERPOOL.

And, finally, special ventilating chimneys are carried up from the sewers above the top of the highest neighbouring buildings, and furnished with Archimedean screw ventilators; of these upwards of 1,200 were at work two years ago.

The whole system of sewers has been completed, up to the present date, at a cost to the town of about £900,000.

The ordinary dry flow is estimated to be about 25,000,000 gallons daily. There are eight outfalls discharging this body of sewage into the Mersey, but all so arranged that they can be connected by an intercepting sewer, and carried to the north end of the town for utilisation.

An attempt has in fact been made to utilise a portion of the sewage by irrigation.

The Liverpool Sewage Utilisation Company was formed some years ago, and obtained a concession of £5,000 from the Council of the borough.

Utilisation of Sewage by Irrigation, &c.

An experimental farm of 60 acres, about eight miles from Liverpool, was taken, with power to extend the area to 1,500 acres; and an engine was erected for lifting 2,000 tons of sewage a day, and taking it in an eight-inch pipe to the land.

The works are described as inexpensive in character, and there appears to be no difficulty in the way of irrigation; but the Committee were informed that the result was not satisfactory.

BOLTON.

BOLTON.

Population, &c.

Bolton is a town situated on the river Croal, with a population of 83,000, on an area of 1,840 acres, and with about 16,250 inhabited houses, giving an average of 45 people to an acre, and 5 in every house.

The town is, however, not entirely sewered; the population of the sewered portion amounting to about 55,000, and the area 1,100 acres. The number of houses connected with the sewers is about 10,000.

Water Supply.

The water supply amounts to 20 gallons a head, and this is entirely supplied by the Corporation, there being no private wells, at any rate for domestic purposes. The Corporation has compulsory powers to supply every house, and exercises these powers (the sub-soil water being contaminated with sewage and not being considered fit for domestic use), charging a water rate amounting to from 1s. to 1s. 2d. in the pound on the rental value of property. Five shillings a year is charged for water supplied to a closet, which acts as a prohibitory tax, and the consequence is there are 500 water-closets only to 7,000 middens.

In the most populous districts, as usual, privies are massed together, and have a common midden, with its usual offensive and unclean accompaniments, some of these places being 10 feet by 6, and 4 or 5 feet below the level of the ground. BOLTON. Midden System.

The middens are uncovered, they drain into the sewers, and all the liquid as well as the solid refuse of houses is thrown into them, with a result which has been already explained. They are emptied and cleansed out when full, on an average of from three to four times a year, and the contents, indiscriminately mixed, are removed to the Corporation depôts, and there separated. The parts having a manurial value are sold at about 1s. a ton, and the remainder is thrown into tips, there being at present no difficulty in finding space for this deposit. It was formerly the custom to make a small charge for emptying and removing the contents of middens; but this had to be abandoned, because it tended to make the people delay the removal as long as possible, until the middens became quite choked with filth—a great source of nuisance and a danger to the public health. Disposal of Soil.

Cost of Scavengering.

The total cost of the scavenging department for 1870 amounted to	£5,730
Receipts	2,850
Leaving a net cost of	£2,880

Sewers.

The surface of the town is generally so steep, and the inclination of the sewers is consequently so great (being never less than, and often far exceeding, 1 in 400), that no inspection or system of flushing is considered necessary.

The sewers are ventilated by down-spouts being taken into them untrapped, and by grids in the crown of the sewers opening into the streets.

Injunction against Corporation.

The average daily dry weather flow is about 1,750,000 gallons, which is discharged unmitigated into the river Croal, at about twelve separate outfalls; but an intercepting sewer, to take the whole to one outfall, is about to be constructed, the Corporation being under an order from the Secretary of State to keep their sewage out of the river.

Utilisation of Sewage.

At the time of the visit to Bolton of the Rivers Pollution Commissioners, a scheme was under consideration for utilising the sewage by way of irrigation; but a scheme of irrigation presented peculiar difficulties. The conformation of the district was such that no land within a convenient distance below the town could be readily made available. The millowners, too, protested against any scheme involving a diversion of the sewage water from their mills, and it was therefore proposed to pump it up the valley to a height of about 300 feet, so that the effluent water, after the irrigation, might be discharged into the river above the town. Difficulties with Millowners.

BOLTON.

This plan is not being carried out, but works are being erected, and, in fact, are almost complete, for the treatment of 500,000 gallons a day, or rather more than a quarter of the daily discharge, on the A B C system.

Treatment of Sewage.

These works are situated close to the river, near a weir, from the top of which a mill-race conveys water to an adjoining mill.

The effluent water from the sewage works would pass naturally by gravitation into the river at the bottom of the weir, but in consequence of the jealously guarded rights of the millowners, the Corporation have been obliged to erect a pumping engine for the purpose of delivering the effluent water into the river at the top of the weir.

MANCHESTER.

MANCHESTER.

Population, &c.

The population of the city of Manchester is 351,000, its area is 4,486 acres, and the number of inhabited houses about 68,000, giving an average of 80 people to an acre, and 5 in every house.

Water Supply.

The water supply is entirely in the hands of the Corporation, and amounts to about 17 gallons a head.

Middens and Water-closets.

It is impossible to make any accurate estimate of the number of water-closets and middens, but the former may be approximately taken as 15,000, and the latter 50,000 in number.

Improved Privies and Ashpits.

Up to the last few years Manchester has been in principle, as it is even now in practice, essentially a midden town, with accumulations of large quantities of decomposing fœcal matter stagnating for months in the midst of the most densely populated districts, and thereby, in the opinion of the Medical Officer of Health, generating many forms of disease, most especially infant diarrhœa.

Exclusion of Fœcal Matter from Sewers.

In Manchester, as in Liverpool, the Health Committee have recognised the importance of removing fœcal matter as speedily as possible from the neighbourhood of dwellings. With this object they have lately introduced an improved privy; and having obtained powers from Parliament for this purpose similar to those exercised, as above explained, in Liverpool, they are compelling owners, among other sanitary improvements, to make structural alterations in privies and ashpits, upon the certificate of the Medical Officer of Health, and according to a particular plan and specification furnished by the Health Committee. The substitution of water-closets for middens, as in Liverpool, is in the case of Manchester impracticable, not only on account of the difficulty of obtaining, even at any cost, the additional quantity of water required, but also on account of the increased pollution of the rivers, which would be the necessary result.

A plan of the new privy and ashpit is shown on Plates III. and IV., and the specification, together with an extract from the Local Government Act, under which the powers of the Health Committee are exercised, will be found in Appendix VII. MANCHESTER.

The opinion of the authorities in Manchester is, that if water-closets had been generally introduced, their rivers would very soon have become intolerable; and as their sewage is at present simply discharged unmitigated into the Irwell and its tributaries, their attention has been directed to keeping as much fœcal matter as possible from entering them, and the Medical Officer of Health is of opinion that if the whole of these matters, solid and liquid, could be excluded, the chief difficulty of dealing with sewage would be overcome.

The new privy, which is introduced by Mr. Leigh, the Officer of Health, may be thus briefly described:—

Description of Improved Privy.

It consists of a common privy, with a small covered ashpit, from the top of which a ventilating shaft is taken to the roof of the house to which it is attached. The floor of the ashpit is of glazed earthenware, absolutely water-tight, and its door, which is either at the side or back, is kept locked, and only opened by the night soil men when they come to empty it. The ashes can only be emptied into the ashpit through the privy seat, (which is provided with hinges and can be raised entirely for this purpose), and must of necessity be poured over, and thus deodorise the fœcal matters.

Dust-boxes are provided for the miscellaneous solid refuse.

Removal of Liquid Refuse.

The house slops and liquid refuse are poured into the sewers through a properly trapped grid in front of the dwellings, and a further improvement is also sometimes adopted by which all continuous communication between the house drains and sewers is cut off, and an escape of sewer gas into the interior is made impossible. The method by which this is effected is extremely simple, and will be most readily explained by reference to the sketch on Plate IV.

Where the new structure has been introduced in courts or thickly populated districts, it has been found convenient to attach two privies to a common ashpit placed between them.

The ashpits are at present emptied regularly once a fortnight; but a weekly emptying is recommended by the Officer of Health.

Cost of the Improvement.

The cost of the new structure, where the ventilating flue has to be carried two storeys high, is from £3 10s. to £4.

Effect of the Improvement.

There are now 1,400 of these, which have replaced the old open midden, representing privy accommodation for about 4,200 houses; and the whole structural alterations have been

MANCHESTER. executed, according to the plan and specification of the Health Committee, by the owners, at their own cost, and, as in Liverpool, on the certificate of the Medical Officer of Health; the direct employment of compulsion on the part of the authorities having been necessary in but few instances.

The Committee visited the lowest part of Manchester, known as "Angel Meadow," an Irish district of about 2,000 houses, where these structural alterations have been in part carried out.

When the sanitary alterations in this district were contemplated, many people predicted that they would only be temporary, that the doors and seats of the privies would be pulled off and burnt, and everything be soon as filthy as before. The alterations had been made about 18 months, no destruction whatever had taken place, and the privies appeared to be in fair working order. They formed a striking contrast to the large open middens, filled with offensive decomposing matter, still remaining, but the removal of which had been already ordered by the Officer of Health.

Increased Value of Property.

Owners of property who formerly objected, after being compelled to make these structural changes at their own expense, have derived such advantage, in the shape of increased rents and a better class of tenants, that they have written voluntarily to the Health Committee, to express their satisfaction with the alterations, which appear to have materially improved the habits of the people, and the cleanliness and comfort of their dwellings. Other owners, recognising the advantage, have themselves applied to the Health Committee for their plans and specifications to guide them in making the same alterations.

Reduction of Death Rate.

The process of conversion is going on as rapidly as possible, and the Officer of Health stated that the effect of the above and other sanitary improvements, particularly the abolition of cellar dwellings, in the converted district, had been to diminish materially fever and diarrhœa, especially infant diarrhœa, so dangerous in large communities, and, in most cases, attributable to a fœcal atmosphere; and that the death rate in 2½ years had been reduced from 33 to 27 in 1,000.

Disposal of Night Soil.

The night soil, ashes, and street sweepings are dealt with in the following way:—

The old uncovered middens, containing the greatest portion of the night soil, are, as usual, emptied, when full, between the hours of 12 p. m. and 9 a. m., and, on an average, about twice a-year; and the ashpits connected with the new privies once a fortnight, as above explained. The contents are brought out into the street, and there separated, the part having a manurial value being carted to the various Corporation depôts, and sold to farmers at about 1s. a ton, or conveyed by rail or river to the country, and sold at the above price, with the cost of freight in addition.

MANCHESTER.

The ashes and refuse which have no manurial value are taken away and tipped into vacant spaces, of which there are, at present, plenty available for this purpose.

Removal of Ashes and Refuse.

The street sweepings are also brought into the various depôts, and there stacked in heaps of from 50 to 100 cubic yards. That collected in wet weather realises about 1s. a cubic yard, or ton; and that collected in dry weather about 1s. 6d. a cubic yard, weighing about 14 cwt.

There is a ready sale for this refuse, for as the streets are paved and not macadamised, it possesses, as explained in the case of Liverpool, considerable manurial value.

Slaughter-house Refuse excluded from Sewers.

The blood, offal, and general refuse of the slaughter-houses in the city is not discharged into the sewers, but is collected daily in vessels provided by the occupiers of such houses, and is taken in covered carts to the Corporation depôts, where it is mixed with the night soil and materially increases its manurial value.

Cost of Scavenging.

The total cost of the scavenging department for the last current year was	£17,660
Total receipts	6,740
Leaving a net cost of	£10,920

Ventilation of Sewers.

There is no special mode adopted in Manchester for the ventilation of the sewers; it is effected simply by means of the down-spouts of houses, and by some of the street grids, untrapped for this purpose. Moreover, as the main sewers have such rapid falls, no regular system of flushing is required, but in special cases they are flushed with water from the nearest source.

Cost of Sewage Works.

The total cost of the sewage works in Manchester up to the present time has been about £340,000, and the sewage is discharged unmitigated at many outfalls into the Irwell, the Irk, and the Medlock; but these rivers arrive at Manchester in so polluted a state, and the quantity of water discharged into them from the sewers is so great—the ordinary daily dry weather flow amounting to 20,000,000 gallons—that the authorities are of opinion that their sewage does not materially increase the pollution, and they have not yet been forced to consider the question of purification.

Pollution of Rivers.

ROCHDALE.

ROCHDALE.

Population, &c.

Rochdale is situated on the river Roach. It has a population of 45,000, an area of 1,131 acres, and 9,600 inhabited houses, giving an average of 40 people to the acre, and 4·7 to every house.

Water Supply

The waterworks belong to the Corporation, and the supply is thirteen gallons a head.

ROCHDALE.

Middens and Water-closets.

Peculiar use of Urine.

The number of water-closets is 372, and of privies 4,000, of which 1,250 are on the new principle about to be described. The old privies are on the usual midden system, and they are emptied of their contents when full, on an average about twice a year. The slops and liquid refuse of houses are either emptied into the ashpits or down the nearest grid into the sewers, as may be most convenient; but as a general rule, the urine from the chambers of small houses, from public-houses, manufactories, and, in fact, wherever it can be preserved in any quantity, is collected in vessels and sold for fulling purposes.

Improved Closets: the Rochdale System.

A new system of dealing with human excreta, known as the Rochdale System, is now being rapidly introduced, and the conversion of the old privies being effected, by nearly the same means as those employed in Liverpool for the introduction of the trough water-closet, and in Manchester for the improved privy—viz., through special powers vested in the Health Committee.

Description of, Apparatus and Mode of Procedure.

Mr. Alderman Taylor, who has devised and patented the Rochdale System, has kindly supplied the following description of it:—

"Beneath each closet seat a receptacle, containing a small quantity of a chemical disinfecting fluid is placed, in which the fœces and urine are collected, the vessels being removed in a covered cart in the daytime to a manure manufactory, weekly or more frequently if required, an important feature of the process being a retardation of fermentation of the excreta, so as to prevent it from fouling the atmosphere and being depreciated in value as a manure, which is effected by frequent removal of the receptacles prepared as above stated.

Disposal of Dry Refuse.

"The cinders and dry refuse from the houses are in like manner collected in common barrels or other receptacles, and when full the contents are tipped into a Corporation cart and removed to the same depôt or manufactory as the excreta, where they are sifted by a winnowing machine, which separates the cinders, refuse, vegetable matter, and fine ash. The vegetable matter is burnt, and its ash and the fine coal ash are used in the manufacture of the manure.

"There is a ready sale for the large cinders at the price of 3s. a ton, and the smaller cinders are used for working the engine at the manufactory.

Production of Manure.

"The fine coal and vegetable ash is mixed with the excreta from the prepared receptacles, the mixture is subjected to a chemical process, and after being allowed to remain in heaps for a period of about 21 days is passed through a screen to ensure perfect mixing. It is then a damp powdery manure, containing all the constituents of the fœces and urine except a large portion of the water.

ROCHDALE.

"By this process a valuable manure is produced, which will allow of the addition of several valuable manurial agents if it be found desirable; but such addition is not necessarily a part of the process.

"By this method of collecting and treating the night soil and refuse of towns there is nothing lost; all is made profitably available, the cinders being found sufficient to raise steam for any motive power required in the process of preparing the manure, and all other kinds of refuse, such as glass, iron, &c., can be disposed of for their usual purposes.

"The urine from the public urinals and that portion which can be collected from dwelling-houses, to which is added a quantity of the same before-mentioned mixture, which is put into the receptacles for night soil, is evaporated and added to the prepared manure.

"The blood from the slaughter-houses is also, by a simple and inoffensive process, brought into a state fit to be added to the prepared manure, and forms a valuable addition to it."

Local approval of new system.

The privies on this system, inspected by the Committee, were found to be perfectly clean and inodorous; and the abolition of middens and separate utilisation of the excreta and ashes appeared to them to be a great sanitary and economical improvement.

Illustrations of the night soil van, dust cart, privies, &c., will be found in Plates V. to VIII.

The alterations, so far, have been adopted and carried into effect by owners of property with facility and readiness, and in no case has it yet been found necessary to exercise the compulsory powers of the Health Committee.

The system has, in fact, been found so satisfactory that the Health Committee are recommending its extension to all the houses in the town; and the manure manufactory, or depôt, which is situated near the centre of the borough, and which has not been found offensive, is being considerably enlarged.

In the erection of all new houses the Health Committee require the adoption of this system, and all the structural alterations from the old to the new are done at the expense of the owner.

Cost of the new system.

The cost of an entirely new privy on this principle is estimated at from £1. to £5., and Mr. Alderman Taylor is of opinion that £2. per privy would be a fair average cost, to which must be added a charge of 10s. for the galvanised iron receptacle and wooden ash-tub, supplied by the Corporation.

ROCHDALE.

Cost of Scavenging.

The night-soil and ashes from the old privies, and the street sweepings are dealt with in the usual manner. The night soil is taken directly out of the town, either in boats or carts, into the farming districts, and the dry rubbish tipped into a gulf, which, it has been remarked, "nature seems to have left for this deposit." The street sweepings are sold as manure (the town being paved and not macadamised), at about 1s. a horse-load.

The estimates of the Health Committee for the old and new night soil departments for the year ending March 31st, 1872, are as follow:—

NEW DEPARTMENT.

Sales of manure	£2,205
Cost of materials and all other items of expenditure	1,962
Balance in favour of Committee	£243

OLD DEPARTMENT.

Cost of scavenging	£1,700
Sales of manure	510
Loss	£1,190

The Health Committee believe that, when these two departments are consolidated by the conversion of all the old ashpits, the payments and receipts will at least balance each other; and probably leave something to the credit of the Corporation, and that the sanitary condition of the town will be greatly improved—a marked improvement in this respect having been already observed where the new system has been introduced.

Corporation manufacturers of Manure.

It is, of course, not essential to combine the separation of excreta with the manufacture of manure, and, in fact, offers have been made to the Corporation to purchase the contents of the receptacles at the rate of 5s. 6d. per ton; but, considering the expense and difficulty which generally attend the removal and disposal of dry rubbish and ashes, Mr. Taylor is of opinion that it is on the whole cheaper to manufacture the manure than simply to sell the excreta.

With the capacity of the present manufactory, the cost per ton, including interest on capital and all other expenses, is 14s.; there is a ready sale for all manure at present produced at 15s., and Mr. Taylor estimates that when the system is extended so as to include the whole of Rochdale, there will be such a diminution in the fixed expenses, in proportion to the total quantity of manure produced, that the cost of production will be reduced to 12s. a ton, and further, that the cost of a work, including plant, horses, carts,

receptacles, etc., but exclusive of site, for the accommodation of a town of 50,000 inhabitants, would be about £5,000. ROCHDALE.

The cost of construction of sewers in Rochdale up to the present time has amounted to £6,500, and the contents, amounting to a daily dry flow of 1,250,000 gallons, are at present discharged unmitigated into the river at several outfalls. An injunction has, however, been obtained to restrain the Corporation from discharging the sewage into the river above a certain weir, and a new intercepting sewer is about to be constructed to convey the whole to a point below this. The question of purification has also been discussed, and the Council have adopted the principle of irrigation, with the condition of excluding as far as possible all excrementitious matter as above explained. Sewerage. Injunction. Utilisation of Sewage by Irrigation.

LEEDS. LEEDS.

The Borough of Leeds comprises not only the town proper, situated on the River Aire, but a large surrounding district, with an area of 34 square miles, a population of 260,500, and 58,340 inhabited houses, giving an average of 4·4 to every house. Population &c.

The area of the town itself is 4,700 acres, with a population of about 175,000, or an average of 37 to the acre.

Leeds has at its command an almost unlimited supply of excellent water, supplied by the Corporation; although complaints have been made as to the quantity supplied in the town itself, in consequence of the large distribution of water in neighbouring townships. Water Supply.

Leeds is essentially a midden town, and all the evils of this system seem here to be developed in their worst form.

An inquiry has been lately made into its sanitary condition by the Privy Council, through one of their Medical Officers, Mr. J. Netten Radcliffe, in consequence of the persistence of excessive mortality from diarrhœa and fever in various townships of the borough. The report of Mr. Radcliffe has been very recently published, and as it includes most of the information which it has been their object to collect, the Committee cannot communicate this in any better way than by the following extracts. On the causes of the production of various forms of fever and diarrhœa, he says:— Sanitary Condition. Government Inquiry.

"The prevalence of enteric fever is chiefly determined by the same local conditions which foster diarrhœa, namely, the pollution of the soil in the vicinity of houses, of the air within houses, and of the water used for drinking purposes, with excrementitious matter. Excrement-sodden earth, excrement-polluted air, and Middens and Water-closets.

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excrement-tainted water are the principal factors of the production of these forms of disease. The extent of prevalence of typhus and of relapsing fever is mainly governed by the degree of overcrowding of families, also of houses in close courts and alleys, and by the amount of destitution."

The different modes of excrement disposal adopted in Leeds, and the extent of use of each method, are shown in the following return (dated December, 1870) :—

Privies (midden-closets)	30,335
Water-closets	6,348
Pail-closets	277
"Privy-sumps" (midden-steads, connected with privies, for the reception of excrement, ashes, and other refuse)	13,500
Dry ashpits	4,500

Defilement of the Soil.

Upon this, Mr. Radcliffe remarks :—"The common privy, with midden-stead, is, in fact, still the ordinary provision for excrement disposal of the great mass of the population, as well of the town as of the borough outside the town. Although long recognised as the filthiest and most unwholesome mode of excrement disposal, it is not only retained in Leeds, but it is perpetuated by the building laws of the Corporation in its most objectionable form." After describing the state and construction of midden-steads in Leeds, he proceeds :—"Midden-steads of the construction here described, gaping wide to the air and rain, facilitate the soakage of their liquid contents into the soil around them, and their walls are saturated with the fluid filth received into them. The disgusting state of the older midden-steads and of the soil into which they are sunk is indescribable. The essential filthiness of these has increased progressively with the deterioration of structure by progress of time. Midden-steads noteworthy as abominations in 1847-48, I saw during the present inquiry with all the additional defilement and decay of structure which twenty-three years' neglect would give. It is actually a serious question whether these midden-steads are most dangerous when full or empty. When emptied, the filth-saturated floors and walls give off a greater amount of disgusting stench than when the receptacle is filled with mixed ashes, house refuse, and ordure. The danger and nuisance from the midden-steads are heightened by the position in which they are too commonly placed. The older part of Leeds is a jumble of close, contracted, and blind courts and narrow alleys, gathered about a few great thoroughfares. Within these confined courts and alleys are placed the astonishing structures I have described, or, where the open space would not admit of this, they have, so to speak, been built into and form part of the houses themselves."

Drainage of Privies into Sewers.

On the drainage of middens into the sewers, Mr. Radcliffe reports :—"The quantity of excremental matter passing into the sewers from water-closets is comparatively small; but a large

additional amount enters them from the drains of numerous midden-steads. There is a constant sluggish flow of fluid excremental matter into the sewers from this latter source; but the diminished wetness, and proportionately lessened offensiveness of midden-steads which is secured by this drainage, has been obtained at the cost of probably a more mischievous if less obvious nuisance. The admission of excremental matter into sewers, unless accompanied with a sufficiency of water to carry it at once away, is a peculiarly dangerous practice. If, also, the sewers have been so constructed and arranged as not to prevent the passage of sewer air from them into the interior of houses, the danger is immeasurably heightened. The condition chiefly provocative of enteric fever and diarrhœa exists in its most dangerous form in improperly constructed and arranged, and imperfectly acting or stagnant sewers, containing excrement. . . . A system of sewers largely receiving sluggish tricklings of excremental matter from great numbers of midden-steads, under circumstances highly conducive to its decomposition, and with hardly any outlets for the escape of the evolved effluvia, except the untrapped or inadequately trapped openings of house-drains: such was the state of the sewerage of Leeds in 1869; such is its state now, for the measures as yet carried out refer only to a part of the evils described, and their application has been too limited to effect any considerable change. The sewerage of Leeds, in brief, while it has largely promoted the surface cleanliness of the town and suburbs, by the removal of house slops and rainfall, has only in an exceedingly limited degree tended to abate that chronic state of excrement-nuisance which has long been, and still is, a cardinal evil in the town and borough, and which it was designed to remove. Indeed, in respect to the drainage of midden-steads, it has been converted into an actual means of aggravating the evil. Any marked benefit to the health of the population which would have been obtained from the sewerage by the abatement of surface nuisance, has been altogether masked by the unwholesomeness of the graver and practically undiminished nuisance from privies. Hence it follows that there has been no return in health and saving of life at all proportionate to the costly expenditure on the main sewers, and, indeed, that there has not been any appreciable return whatever so far as existing data show."

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Dangers of excrement in sewers.

The descriptive portion of the report concludes with a summary of the various causes conducive to the excessive mortality, viz:—"The causes which have chiefly given rise to this excessive mortality are—(1) In respect to diarrhœa and enteric fever: (*a*) An indefensible method of excrement disposal, namely, the common privy with midden-stead, constructed and perpetuated in its most offensive and dangerous form, although its mischievous effects upon the health of the population had been repeatedly indicated during the past forty years. (*b*) A faulty regulation of the sewers, the necessary means to prevent flow of sewer air into houses, and into closed and blind courts and blind yards, having been neglected, and no provision made for systematic flushing, under conditions in

Causes of Disease.

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which such flushing was peculiarly needed. (*c*) A water-supply in quantity either insufficient or insufficiently adapted to meet the proper requirements of the sewers, and of which the impure quality was probably not without influence. (2.) In respect to fever generally: (*a*) The prevalent custom of building houses back-to-back, and particularly the aggravation of the unwholesome states arising from this custom (or independently of it, when through ventilation of houses is not provided), by their erection in closed and blind courts and blind yard; also the use of cellar dwellings."

Recommendations for Improvement.

The report concludes with recommendations comprising among others, the following:—

1. A system of scavenging which will admit of all excremental matters and dry house refuse being removed (1) at least once daily from all localities in the town and borough, where the necessity for such removal is indicated by the Medical Officer of Health; and (2) at least once every week in all other parts of the town and borough.

2. The filling up of all midden-steads constructed on the plan at present in vogue, and the substitution for them, as the only receptacle for excrement and dry house refuse, solely of the space between the privy seat and the floor of the privy.

3. The construction of all privies so that the following requirements may be satisfied:—The space between the privy seat and the floor to be the receptacle for the excrement and dry house refuse; the floor and walls of this receptacle to be impervious to moisture, and not liable to leakage into the soil beneath; the seat to be so arranged that the ashes and dry house refuse can be readily thrown upon the excrement so as to cover it, and that the contents of the receptacle can be easily removed, and the walls and floor of the receptacle cleansed by flushing, or otherwise, if necessary; the general structure to be so designed that rain will not find an entrance to the contained filth.

As to the Sewerage: *(a)* A thorough investigation should be made of the state of sewerage of those localities in the town concerning the sewerage of which the Corporation maps and records give no information; and the necessary measures should be taken to amend the defects which may be discovered. *(b)* The alterations which have been suggested in the construction of privies with midden-steads would effectually remove the evil now resulting from the drainage of midden-steads into the sewers. *(c)* The question of flushing the sewers, even if the sewers be relieved from the excremental matter trickling from midden-steads, should receive consideration. *(d)* A plan of ventilation of the sewers should be decided upon and carried out with the least practicable delay."

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The report from which the above extracts have been made was laid before the Town Council of Leeds on Wednesday, August 9th, and the following report from the Sanitary Committee thereon was unanimously adopted:—

Report to Corporation. Adoption of the Box System.

"The Sanitary Committee have considered that portion of the report which refers more especially to their department, and have to recommend to the Council: (1) That in order to carry out the spirit of Mr. Radcliffe's report, this Committee recommend that the box system be adopted throughout the borough in the place of privies, and that the excrement and vegetable and other matter be removed without delay. (2) That an order, when required, be served upon all owners of property to fill up the ashpits connected with their premises to the satisfaction of the Borough Surveyor within one month from the date of such order. (3) That this Committee provide the necessary receptacles, and also provide the required accommodation for their use, at the expense of the Corporation. (4) That the necessary number of horses and wherries required be provided by the Night Soil Committee."

Cost of Scavenging.

The cost of the night soil department for the last financial year is as follows:—

Total cost	£9,440
Sales of manure	£5,610
Net cost	£3,830

Injunction against Corporation.

The whole sewage of Leeds, amounting to a daily dry weather flow of 11,000,000 gallons, or 49,000 tons, has up to the present time been discharged unmitigated into the river Aire. An injunction has, however, been lately obtained against the Corporation to restrain them from turning the sewage in its present polluted state into the river, and also to restrain them from making any further connections with the existing sewers until the injunction has been complied with. With this object, the Corporation have determined to make an experiment on the A B C principle of purification, and have accordingly entered into an agreement with the Native Guano or A B C Company, and erected works for the treatment of a daily volume of 2,000,000 gallons.

The Corporation reported to the Court of Chancery the efforts being made to comply with the injunction, and the amount of money expended on the sewage works, and six months' extension of time from September 1st, 1871, was thereupon granted, at the expiration of which the Corporation were ordered to report further upon the progress made in complying with the injunction.

Application to Birmingham.

The Committee have quoted so fully from Mr. Radcliffe's report upon the sanitary condition of Leeds because they believe that it actually presents a fair description of the state of many parts of Birmingham at the present time; that all the evils of the

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midden system, if not quite so developed, are, at any rate, of the same kind; and that as great a necessity exists for their investigation and removal.

NOTTINGHAM.

NOTTINGHAM.

Population, &c.

The population of Nottingham is 86,929, its area 1,996 acres, and number of houses 18,025, giving an average of 43 to the acre, and 4·8 to every house.

Privies and Water-closets.

Of the 18,000 houses, 15,000 are connected with middens, 2,000 with water-closets, and the remainder with a tub-closet lately introduced.

Tub-closets.

The sewage, amounting to a daily dry weather flow of about 4,000,000 gallons, is discharged into the river Trent. In order to prevent the pollution of the river the new tub-closet has been introduced, by means of which it is intended to exclude all solid and liquid excreta from the sewers; and with the same object the urine from public urinals, 10 in number, is also collected in cisterns holding from 4 to 5 tons, the contents of which are readily sold for 2s. 6d. a ton. The water-closets and middens are now being rapidly converted into tub-closets which receive the urine, fœcal matter, and dry ashes. 400 of these are now in operation, and are found to work satisfactorily. They are cheaper than water-closets in their original cost, are not injured by frost, or liable to be stopped by improper substances thrown into them; there is no soakage into the surrounding buildings or soil, as is often the case in ill-constructed privies and ashpits; and lastly, the whole agricultural value of the contents is retained and utilised, instead of being wasted and becoming a nuisance by polluting the sewers and river.

These 400 closets are connected with 1,000 houses, and a population of about 5,000. They are inspected and emptied at least twice a week, and this frequent supervision has a good effect in enforcing cleanliness on the part of the occupiers. Two men and a one-horse dray have been found sufficient to keep in order and remove the contents of the whole number.

The tubs are disinfected with McDougall's preparation.

It is anticipated that in about eighteen months the conversion to this system of all the privies and middens in the borough will be effected.

There are also 61 licensed slaughter-houses in the borough, which are inspected once a week at least, and all manure, blood, offal, and garbage therefrom are put into tubs of approved construction, and the contents removed once in forty-eight hours.

KINGSTON-UPON-HULL.

HULL.

This town has a population of 123,000, and 27,500 inhabited houses, of which about one-eighth have water-closet, and the remainder privy accommodation. Population, &c.

In the case of new buildings, the Corporation compel the erection of a separate privy for every house, constructed on the "bevil" principle, and bedded in cement. Closed Ashpits.

For the collection and removal of night soil the borough is divided into districts of about 500 houses each, which are let to contractors, who are paid from 3d. to 1s. 6d. per house. Cost of Removing Soil.

No open ashpit is tolerated in the borough, and no accumulation of night soil, it being the duty of the contractors to call at every house once a week and remove therefrom all household refuse.

The present annual cost of this removal is £1,350.

At the same rate per head, the cost in Birmingham should be about £3,700, but it, in fact, exceeds £6,250.

The refuse from slaughter-houses is also utilised in the following way:—The blood from all the slaughter-houses in the borough, 83 in number, is carefully collected when fresh, in shallow tins, and allowed to stand until the clot separates from the serum. The serum is then drawn through perforated zinc strainers into casks or tins, placed upon a hot-air drying kiln, and dried into albumen, which is used by calico printers for fastening colours. The clot is also subjected to a heating process until all the water is drawn from it, and the residue is used for manure.

The following general conclusions may be gathered from the facts which the Committee have endeavoured to lay clearly before the Council in the foregoing descriptions: Conclusions.

1. That the midden system of collecting excreta in the densely populated districts of towns is universally condemned on account of the pollution of the earth, air, and water in their vicinity which is its inevitable result, and that it is essential to the health, cleanliness, and comfort of the inhabitants of such districts that all fœcal matters should be removed with the greatest possible despatch. Open Ashpits and Middens objectionable.

2. That this can be effectually done either by the water-closet system, as at Liverpool, or otherwise by the Rochdale, Manchester, or other systems, which not only secure a rapid System at Liverpool, Manchester, and Rochdale.

HULL.

removal of these matters, but effectually exclude both their solid and liquid constituents from the sewers.

3. That some such system as the Manchester or Rochdale system is being largely introduced in preference to an extension of the water-closet system, where there is a difficulty of dealing with the sewage at the outfall.

Rochdale System preferable.

4. That the Rochdale system appears preferable to the Manchester system, because it deals separately with the excreta and dry refuse, and renders possible the most perfect and economical utilisation of each.

Slaughter-houses, &c.

5. That the refuse from slaughter-houses, public urinals, and cattle markets may be advantageously collected and utilised.

Medical Officers of Health.

6. That where structural alterations or special modes of building are required, it is found most convenient to have them carried out through the special and stringent powers of a Sanitary Committee or Medical Officer of Health.

Other Systems.

In addition to the information obtained on the methods of dealing with fœcal matters in the towns above referred to, the Committee have also inquired into various other methods which have been suggested from time to time. The most important of these are the earth-closet system and Captain Liernur's system, to which a very brief allusion will suffice.

Earth-closets.

The earth-closet system is founded upon the undoubted fact that fine, suitable earth, carefully dried, possesses the property of completely deodorising fœcal matter when mixed with it in certain proportions, and, further, that the mixture, after being kept awhile and dried, possesses the same power and may be used again and again for the same purpose.

Quantity of Earth required.

Experiments on this property have shown that the quantity of suitable earth required for deodorising a single stool is about 1½lb., and that for perfect deodorisation in closets on this system there are two essential conditions—one, that the earth should be perfectly dry, the other that it should be applied in detail, (*i.e.*, each stool should be covered), Experiments have also shown that the power of deodorisation varies with the quality of soils, dry clay and loam possessing it in the greatest degree, chalk in a less degree, and sand and gravel having little or no effect at all.

But in practice it has been found that 4½lbs. per day per head is necessary for all purposes, and this, for a population of 343,000, would amount to 689 tons per day.

System inapplicable to large towns.

It is obvious that any system of this kind, though it might be advantageously used in a village, or at particular places under favourable local conditions, would be impracticable in large towns. The quantity of earth required, the difficulty of procuring it, the expense of bringing it to the houses of the inhabitants and of removing it, the sifting and drying required, the care required in keeping the earth dry and throwing it over each stool in sufficient quantity but without excess, with the fact that the system would be chiefly used by the least careful class—all these difficulties would render its success absolutely hopeless.

The use of sifted ashes instead of earth might possibly lessen, but would not remove, the inherent difficulties of working such a system. Ashes do not possess the same deodorising power, a greater quantity would be necessary, they would have to be properly sifted by officers of the Corporation, and the same certainty would still remain of their not being properly applied.

Liernur's System.

For a complete description of Captain Liernur's system reference must be made to Krepp's work on the Sewage Question.*

It consists of an elaborate plan for the interception of fœcal matter, somewhat in the following manner:—

The privies of a number of houses are connected, by means of small iron pipes, with a central reservoir, placed under the pavement of the street. The connecting pipes are provided with valves so that the communication between each privy and the street reservoir can be established or cut off at will.

The reservoirs are constructed of boiler plates strong enough to resist the atmospheric pressure under which they are both filled and emptied. This is done during the night in the following manner:—

A locomotive steam engine, working an air-pump, is brought to a reservoir, which is then connected with the pump, and exhausted.

The valve connecting a privy with the reservoir is then opened, and the contents of the privy are discharged into the reservoir by atmospheric pressure. When all the privies connected with it have been thus emptied and their valves closed, the reservoir itself is emptied by the same process into an hermetically closed wagon, and taken away.

Rochdale System simpler and equally effectual.

The simple system of intercepting and removing excreta adopted at Rochdale and at other places, seems to possess all the advantages, without the disadvantages, of these costly and cumbrous processes.

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* The Sewage Question: by F. C. Krepp. Longman, Green, & Co., 1867.

Rochdale system.

The removal by the Rochdale system is effected by day, and is inoffensive and expeditious, the pail being simply covered with a close-fitting lid, removed in a cart, and an empty one left in its place.

There is nothing about the system requiring thought or care on the part of those who use it. This is essential for its success in a large town, where it must be chiefly used by those who are least accustomed to restraint, control, or responsibility.

Tried in the Birmingham Workhouse.

Besides being adopted in Rochdale and other towns, it has been independently introduced into the Birmingham Workhouse by Mr. Sharp, the master of that institution, who has been kind enough to furnish us with the results of his experience of its practical working, in a letter which is appended to this Report. (See Appendix VIII.)

In use on the Continent.

Finally, it is in use in various Continental towns, such as Gröningen, Antwerp, Ostend, Strasbourg, and others; and experience there shews that the system is, at least, self-supporting, and in most cases can be worked so as to produce a profit.

Improvements recommended for Birmingham.

The Committee have now given a detailed statement of the actual condition of Birmingham with respect to the various subjects involved in the question of the disposal of sewage; also of their investigations in other towns, and of the improvements, especially in methods of dealing with excreta, introduced therein.

After a careful comparison and consideration, they are convinced of the necessity of the introduction of similar improvements in Birmingham, and have come to the conclusion that it is not only possible, but, considering the difficulty of dealing with the sewage at the outfall, highly expedient, to introduce a system of interception from the sewers of excrementitious and other polluting matters.

Abolition of Middens.

As a general rule, the interception of excrementitious matters involves the abolition of middens and the substitution of a new privy system.

Treatment of Water Closets.

A great part of the solid fœcal matter now discharged into the sewers, through water-closets, may also be intercepted by some such plan as that recommended by Mr. Edwin Chesshire, of this town. (See Appendix XI.) But the Committee feel that it would be impossible to deal with water-closets in the way that they have shown it to be possible to deal with middens, for two reasons; first, because they can substitute for them no system which is so well adapted for the interior of houses where water-closets are necessarily placed; secondly, because there is not the same sanitary objection to them, as they secure what is one object of the abolition of

middens to secure, viz., a rapid removal of fœcal matter from the vicinity of dwellings.

Laying aside sanitary considerations, this fact remains: if fœcal matter is introduced into the sewers, it must be extracted or rendered innocuous by some method of purification at the outfall, at a considerable cost to the ratepayers.

Tax on Water-closets.

It would, therefore, be manifestly unjust to tax one portion of the community by compelling them to abolish their middens, and so to exclude their fœcal matter from the sewers, unless at the same time the other portion, who are still allowed to introduce it through their water-closets, are specially taxed for the cost of purification at the outfall.

The Committee therefore propose a special tax on water-closets, combined with the abolition of middens; and thus all, though not dealt with in the same manner, are dealt with with equal fairness.

With respect to the interception of liquid wastes from manufactories, the Committee recommend the adoption of the suggestions contained in the report of Dr. Frankland, before quoted.

Improvements in the present system of ventilation and flushing of sewers might, doubtless, be introduced with advantage; but as the object is to prevent the accumulation of gases in the sewers, and emanations in the interior or vicinity of dwelling houses, and as these gases, to a great extent, result from the decomposition of fœcal matter, the consideration of these improvements may be deferred until the effect of the interception of such matters has been carefully observed. At the same time, the attention of the Council should be directed to the system already noticed as being introduced in Manchester, which effectually prevents any emanation of sewer gas in the interior of houses from ordinary drains. This system simply consists in bringing the sewer up to the outside wall and terminating it there by a trapped grating, on the top of which the house drains discharge their contents in the open air. (See Plate IV.)

The Committee also desire to draw the attention of the Council to the expediency of lessening, as far as possible, the immense amount of road detritus which is carried into the sewers through the present gully traps, and accumulates at the outfall. This is the result of macadamised roads, and of allowing the street sweepings to enter the sewers, and, in the opinion of the Borough Surveyor (see Appendix IV.), can be only effectually dealt with by a more systematic paving of yards, courts, footpaths, and carriage ways.

The recommendations of the Committee on this portion of the sewage question are as follow:—

Recommendations of Committee.

1. The gradual abolition of middens, and substitution of a new privy system, based upon the principle of exclusion from the sewers, and weekly collection of all excrementitious matters, solid and liquid.

2. A system, to be developed in connection with the above, of exclusion from the sewers, and collection of refuse from slaughter-houses, cattle markets, urinals, cowhouses and stables.

3. An experimental trial of the Rochdale and Manchester systems, on a sufficiently large scale, and under the strictest supervision; and, ultimately, an extension to the whole town of that system which shall be found to be the most efficient.

4. The imposition of a rate on occupiers, in respect of water-closets connected with the sewers, on a scale to be sanctioned by the Council.

5. That a register be prepared and kept up, of all connections with the sewers, and that no future connections with the sewers should be made without the consent of the Council.

6. The exclusion from the sewers of the refuse from the works of German silver manufacturers, galvanisers, wire drawers, and manufacturing chemists, and from such other works the refuse from which may, from time to time, be found to interfere with the utilisation of the sewage of the borough, unless such refuse shall, previously to being discharged into the sewers, have been so treated as not to interfere with such utilisation.

Expected Economy.

Finally, the Committee believe that the adoption and efficient carrying out of these recommendations will secure—

1. A great sanitary reform.

2. A gradual diminution of the expense and difficulty of dealing with the sewage at the outfall.

3. A material diminution of the expense of the Night Soil Department.

PART II.

GENERAL TREATMENT OF SEWAGE.

Treatment of Sewage at the Outfall.

Having now, for sanitary and other reasons, recommended the interception of excrementitious and other matters which constitute the chief source of sewage pollution, the difficult subject of the treatment of the vast volume which must necessarily, even under the most perfect system of interception, be discharged at the Saltley outfall, remains to be considered.

Effect of Interception.

It is impossible to estimate the effect of the proposed interception on the quality of the sewage at the outfall, but the Committee have learnt, as before explained, that the number of water-closets is comparatively small, and that they only receive the excreta of about 20,000 out of 345,000 people.

There can be little doubt that, in a well drained midden, nearly all the fluid and soluble parts of the excreta find their way into the sewers, and some even of the solid constituents will also be drained away, especially in wet weather. Consequently the Committee believe that if their recommendations on this point are fully carried out, the result will be the exclusion from the sewers of a large proportion of the excreta of 325,000 people.

Now, it is generally estimated that the fluid parts are more valuable than the solid in the proportion of about seven to one, and it is also the fluids which contain the organic nitrogenous constituents so difficult to extract by any chemical process—especially when diluted with about 350 times their volume of water by the present water carriage system. Surely, then, a simple and direct utilisation of these matters, by interception, must necessarily materially diminish the difficulty of purification.

Necessity of Purification.

But under any circumstances some treatment will always be necessary for the purification of that portion of the sewage which, after all possible interception, must be discharged at the outfall; and further, the introduction of interception can only be gradual, while the Council have at once to meet a present and pressing difficulty, occasioned by the injunctions of the Court of Chancery. Although, then, the Committee believe that the adoption of their recommendations must gradually lessen both the pollution and volume to be dealt with, yet it is necessary now to attempt the purification of the present volume, amounting to a dry weather flow of about 17,000,000 gallons daily.

Of the Court of Chancery.

Character of Sewage at Outfall.

With respect to the character of the sewage now discharged at Saltley, the report of Dr. Voelcker, published by the Public Works Committee, is to the effect that it is somewhat more diluted than average sewage in consequence of the large water supply, and that it has one peculiarity, viz., that it contains a quantity of green vitriol, or sulphate of iron, which, though injurious to vegetation, is, at the same time, a great disinfectant.

Possible extraction of Solids.

Dr. Voelcker further reports that the solid matters in an imperial gallon of average Birmingham sewage are—

In suspension	(organic 7·71 grs.)	...	15·11 grains.
In solution	(organic 6·23 grs.)	...	65·05 „
	Total ...	...	80·16 grains.

It is, of course, a comparatively simple matter to extract, by subsidence or otherwise, the larger portion of the solid suspended impurities; but the great difficulty is to extract the polluting part of matters held in solution, chiefly consisting of nitrogenous organic matter (which, according to the Rivers Pollution Commissioners, rapidly enters into putrefaction, and is an active agent in the pollution of rivers), ammonia, and phosphoric acid—the value of the dissolved being, as before stated, estimated at seven times that of the suspended parts.

The hope of extracting these valuable constituents in a portable and marketable form has, in spite of failures, constantly stimulated the efforts of chemists.

Various Processes of Extraction.

The Committee have endeavoured to inform themselves of the various processes which have been tried to effect this object, partly by personal investigation, and partly by reference to the various published works on the subject. A brief explanation of some of the principal of these processes will illustrate the great difficulties which surround the question, and may be useful in assisting the Council to arrive at a sound conclusion.

The various methods employed for the purification of sewage may be classed under the following heads:—*Precipitation*, *Filtration*, and *Irrigation*.

PRECIPITATING PROCESSES.

All these processes consist in adding to the sewage various chemical reagents, with the object of precipitating a portion of the dissolved constituents, and of assisting the precipitation of the suspended constituents, and ultimately of realising the value of the precipitate as manure.

Precipitation Principle of the Lime Process.

The Lime Process has been employed on a somewhat extensive scale at Tottenham, Blackburn, and Leicester. It consists in adding to the sewage a certain proportion of milk of lime—about one ton to one million gallons—agitating the sewage by machinery to ensure a thorough mixture, and then allowing it to flow into a settling tank, where the suspended solid matter is quickly precipitated with a certain portion of the dissolved matter. The supernatant water is then drawn slowly off, considerably clarified. The deposit, in the form of a highly putrescible mud, is taken out, dried, and sold for manure; the process of drying

being tedious and offensive, and in winter almost impossible. This process is the simplest and least costly of any, but, according to the report of the Rivers Pollution Commissioners, the effluent water, though clarified, is not purified or fit to be admitted into a running stream, since it still contains about one-half of the putrescible organic matter, which is precisely what is most important to keep out. Moreover, as the effluent water still contains most of the valuable constituents, the manure is of little value, and it is difficult, and on a large scale might be impossible, to dispose of it. The *Medical Press* observes on this process:—"In a sanitary point of view, the careful precipitation of sewage with lime has been successful, although it has not been found a success commercially, for the precipitate is chiefly composed of carbonate of lime and non-nitrogenous organic matter."

Imperfection of Lime Process.

Lime and Chloride of Iron.—This process is a modification of the one above mentioned, and has been applied at Northampton to the sewage of 40,000 people.

Lime and Chloride of Iron.

It is thus described in the first Report (vol. 1, page 58) of the Rivers Pollution Commissioners:—"Each million gallons of sewage is mixed with twelve bushels of lime and about six gallons of chloride of iron, the chloride of iron being manufactured on the premises, at a cost of £6. a ton. The defecated sewage is afterwards submitted to upward filtration, through a stratum of calcined iron ore eight inches thick; but we consider that, beyond the separation of suspended matters, which would be equally effected by subsidence, this latter operation is nearly useless. The effluent sewage, after a flow of 1½ mile through a culvert, is discharged into the river Nen in a nearly clear and apparently innocuous condition. Nevertheless, analysis shows that the discharged sewage still contains in solution a large amount of putrescible organic matter; but the putrescence of this matter was doubtless delayed by the chloride of iron used in the treatment until the stream had flowed beyond the point where we examined it. It is well known that chloride of iron possesses this property in a remarkable degree; but the putrefaction of the disinfected sewage is only delayed, not ultimately prevented. In fact, the river Nen does eventually become putrid in consequence of this discharge into it, and an injunction has been granted by the Court of Chancery to restrain the Improvement Commissioners from discharging the sewage of the town into it after the 1st of June, 1870."

The result of the process appears to be that the suspended matters are almost entirely removed, together with about one-sixth of the ammonia and rather more than one-half of the organic nitrogen.*

Defects of Process.

The Improvement Commissioners at Northampton are now adopting a scheme of irrigation.

* Treatment and Utilisation of Sewage: by W. H. Corfield, M.A.; 2nd Edition. Macmillan & Co., 1871.

Holden's Process.

Holden's Process.—This process has been tried as an experiment on about 130,000 gallons daily of the Bradford sewage. It consists in adding to the sewage a mixture of sulphate of iron, lime, and coal dust, and allowing it to flow through a series of subsiding tanks.

According to the Rivers Pollution Commissioners, an analysis of the effluent water shows that while the process separates the whole of the suspended matters, it not only fails to remove the putrescible organic matters in solution, but actually increases their quantity, by causing some of the putrescible matter in suspension in the original sewage to pass into solution. The effluent water could not, therefore, be admitted into a running stream without causing pollution. Moreover, the manure may be considered practically worthless.

Experiments at Bradford.

The sewage of the town of Bradford, with a population of 140,000, is now handed over to the Peat Engineering and Sewage Filtration Company, on an agreement by which the Corporation are to erect the necessary works, and the Company to take the sewage, with the responsibility of its purification. The merits of this process will, therefore, shortly be fully tested.

Bird's Process.

Bird's Process, which has been tried at Stroud and Cheltenham, consists in treating the sewage with crude sulphate of alumina, and subsequently filtering it through coke.

Experiments at Stroud.

The following, on the treatment at Stroud, is extracted from the Rivers Pollution Commissioners' Report:—"From 150,000 to 200,000 gallons are daily treated with the sulphate (made by adding 120 lbs. of sulphuric acid to six cwt. of pulverised clay). The sewage flows into a depositing tank, and afterwards through three coke filters. The coke is renewed in the first filter every fortnight, and in the last every month. The foul coke is burnt under the boiler. From the analyses of the raw and effluent sewage it is evident, first, that the sewage was very weak; and, secondly, that the effluent liquid, though much improved, was still not of the degree of purity which would render it admissible into a running stream. Moreover, if stronger sewage were treated, the effluent water would doubtless be still more objectionable."

Lenk's Process.

Lenk's Process.—The following account of another of the alum processes is extracted from the Tottenham Report of May, 1870:—"This process was tried for more than a week at the Tottenham works, with very fair results. A cask of water from the tank became, after settling, perfectly clear, free from all smell—two gold fish living in it for some weeks. Three to three-and-a-half cwts. of chemicals were used per day for about 700,000 gallons of sewage, or one ton per week, at a cost of £6 10s."

Extracts from Dr. Voelcker's report upon the system:—"Lenk's deodorising liquid certainly effects a ready precipita-

tion of suspended sewage matters, and at the same time removes a very large proportion of obnoxious soluble refuse matters. The sample of deodorised Tottenham sewage examined by me certainly was very satisfactorily disinfected. Sewage, after efficient treatment by Lenk's process, in my judgment, may be poured into a water-course without causing a nuisance like ordinary sewage. I abstain from expressing an opinion respecting the economy or feasibility of introducing this or any other disinfecting process in dealing with the sewage, for I believe every case in which the disposal of sewage is concerned must be judged according to local cicumstances. Experience has shown that the profitable manufacture of portable manures from sewage deposits has yet to be discovered. The smaller the amount of foreign matters, having little or no fertilising value, which is introduced into the deposit, the greater the chance will be of its finding a sale. Lenk's process simply precipitates organic fertilising matters, and, unlike the lime process, introduces into the deposit no appreciable amount of bulky and useless material."

Lenk's Process.

The process was experimented on at the Tottenham works by the owner of the patent himself, but the tanks were not of sufficient capacity to fairly test the system. It was not continued by the Tottenham Board of Health, on account of the expense of the deodorising agent and the uncertainty as to the value of the manure.

Experiments at Tottenham.

Forbes's Process.—This consists in treating the sewage with a solution of phosphate of alumina dissolved in sulphuric or hydrochloric acid, and the great difference between it and other precipitating processes is that the agent employed contains itself most valuable fertilising properties. It is, moreover, a powerful disinfectant, arresting decomposition, so that the drying of the deposit is less offensive than in other processes. It is also a valuable preliminary to irrigation, because the effluent water, while made perfectly clear and inodorous, is further enriched by the addition of soluble phosphates, and its manurial value thus greatly increased. According to Dr. Voelcker's report, the effluent water is more valuable, bulk for bulk, than the raw sewage for irrigation purposes.

Forbes's Process.

If, however, it is not intended to irrigate, but simply to discharge the effluent water into a stream, a quantity of milk of lime is added in the subsiding tank for the purpose of precipitating the phosphates in solution, and it is then proposed to pass the effluent water through a filter composed of coke, charcoal, or some other carbonised substance, so as to remove any organic matter remaining. The filter must be reoxidised by exposure to the atmosphere, the water being run out and air admitted every twelve hours.

This process is now being experimented upon on a somewhat large scale at the Tottenham sewage works, and the amount of phosphate required appears to be about 35½ cwt. for one million

Experiments at Tottenham.

Forbes's Process: Cost.

gallons (further experiments have indicated that the proportion required is less than this amount), and about half the same quantity of lime, or, together, about 2½ tons per one million gallons. The price of the phosphate is about £3. 10s. per ton, but considerable difference of opinion at present exists as to the value of the resulting manure.

Efficacy of Process.

Dr. Voelcker reports: "Any person who has once seen the extremely rapid and simple process by which foul raw sewage is defecated and clarified by this plan, cannot but be struck with the rapidity and efficient manner in which raw sewage is rendered almost as clear and inodorous as ordinary water. I have therefore no hesitation in saying that effluent sewage, as thoroughly purified as I saw it done at the time of my visit, may be safely discharged into a watercourse without fear of causing a nuisance."

A B C System.

The ABC, or Sillar's Process.—This consists in treating the sewage with a mixture of alum, blood clay, and charcoal, with various other ingredients in smaller proportions. After a perfect mixture, by machinery erected for this purpose, the sewage flows into a tank, where the precipitation is allowed to take place.

Report of Rivers Pollution Commissioners.

This process has been made the subject of a special inquiry and report by the Rivers Pollution Commissioners, who instituted a series of observations and analyses of the raw and effluent sewage at Leicester and Leamington, where it was being tried. The conclusions arrived at by the Commissioners were very unfavourable, and are summed up in their report, as follows:—

"Our investigation into Sillar's, or the ABC process of treating sewage, as carried out at Leicester and Leamington, extending over nearly two years, has led us to the following conclusions:—

"1. The process removes a large proportion of the suspended impurities from sewage, but on no occasion, when we have seen it in operation, has this removal been so complete as to render the effluent sewage admissible into running water.

"2. The ABC process removes a very small proportion of the soluble polluting matter from sewage. After treatment, the effluent sewage is very little better than that which is obtained by allowing raw sewage to settle in subsidence tanks.

"3. The manure obtained has a very low market value, and cannot repay the cost of manufacture.

"4. The manipulations for the extraction and drying of this manure are attended with a nauseous odour, especially in warm weather, and would occasion a serious nuisance if the works were situated in or near a town."

Trials at Crossness, &c.

After such conclusions, so strongly expressed, it is somewhat remarkable to find that the A B C still enjoys a greater amount of popular favour than any of the present precipitating processes. The shares of the Company are at a high premium, and new improved works—which the Committee, are informed by Mr. Sillar, the representative of the Company, will materially facilitate the process and lessen the expense of production—are being erected at various places: at Crossness, for the treatment of 500,000 gallons daily of the London sewage (the total quantity of which amounts to 47,000,000 gallons); at Southampton, for the treatment of the whole, about 2,000,000 gallons; as well as at Bolton and Leeds, where the works in progress were inspected by the Committee.

The average dry weather flow of sewage at Bolton is 1,750,000 gallons, 500,000 gallons of which are about to be treated on the A B C principle. For this purpose works are being erected by the Corporation at a cost of about £6,000, and all expenses of plant, working, and ingredients are also to be borne by them, the A B C Company taking 25 per cent. of the manufactured manure as a royalty for the use of their patent.

Alleged financial results.

The Committee obtained from Mr. R. G. Sillar, the representative of the Company, and acting manager for the Corporation, the following estimate of the quantity and cost of the ingredients required per day for the treatment of 500,000 gallons.

INGREDIENTS.

		£	s.	d.
14 cwts. clay 7 cwts. sulphuric acid	for crude alum ...	0	1	0
		1	12	8
1 ton refuse animal charcoal, 1s. per ton, and carriage 2s. 6d.	... ...	0	3	6
Clay, 5 tons	... ...	0	7	0
Establishment wages, expenses, and other ingredients	... ...	3	10	0
2 tons of coal	... ...	0	11	0
		£6	5	2

As seven tons of solid ingredients are thus used, seven tons, at least, of manure must be the daily result of the treatment, the value of which Mr. Sillar estimates at £3 10s. per ton.

	£.	s.	d.
Thus we have daily profit	24	10	0
Daily cost	6	5	2
Net estimated profit	£18	4	10

A B C system.

Trials at Leeds.

At Leeds, with a daily dry weather flow of eleven million gallons, works are almost completed for the treatment of two million gallons by this process, the following being the principal terms of an agreement entered into between the Company and the Corporation:—"The Corporation to erect buildings, plant, and machinery on their own land at the outfall, and at their own cost, for the purification of two million gallons daily." The necessary works for this purpose have been erected at a cost of about £10,000. "The Company to find working expenses and materials. The Company to pay the Corporation five per cent. on all their outlay, and fifteen per cent. of the net profits from the sale of manure. The Corporation to grant the whole sewage of Leeds, and erect additional works, and grant a lease of the same for twenty-four years if the system is successful."

At the old A B C works of Leicester and Leamington, the process of drying the precipitated mud was both difficult and expensive. Mr. Sillar informed the Committee that this difficulty is overcome by improvements in the method of manufacture, the mud being now conveyed from the subsidence tank into special covered chambers, and placed on a floor of galvanised iron plates, beneath which hot air or steam is introduced, by which the drying is rapidly effected.

The above mentioned are only some of the many precipitation processes which have been patented and experimented upon. Some of them might doubtless, under favourable local circumstances, be adopted with advantage on a small scale. The A B C process, or others, may then succeed in satisfactorily clarifying the sewage and getting rid of injunctions—the most perfect undoubtedly do succeed in precipitating all suspended matters—but all seem to fail in extracting a great portion of the soluble, and at the same time the most valuable, constituents.

The success or failure of the A B C system must very soon be absolutely determined by the operations at Bolton, Leeds, and Crossness. At Bolton especially, in the opinion of Mr. Sillar, the conditions were especially favourable for the experiment, on account of the quality, abundance, and cheapness of the ingredients required.

Process not applicable to Birmingham.

Under these circumstances, a further experiment at Birmingham would seem to be superfluous, while it would be in the highest degree imprudent to attempt, without further knowledge, to deal with the whole by this or any similar process. The annual expense of ingredients and working would be very great; the amount of ingredients added to the great mass of precipitated matter would be enormous and unmanageable; and while the expense would be certain and constant, the income derived from the sale of manure would be uncertain. Moreover, the purification would at best be partial, and the process of manufacturing the manure, if carried on at Saltley, might cause as great a nuisance as that now

complained of, so that the chance of satisfying either of the existing injunctions would be doubtful.

Defects of Precipitating Processes.

The Committee conclude their observations on the precipitating processes for purifying sewage by two quotations—one from Professor Corfield, an ardent advocate, the other from F. C. Krepp, as ardent an opponent of irrigation.

Krepp, page 36.—"These instances are enough to prove that solids extracted from fluid sewage cannot be manufactured into dry manure so as to pay for the trouble. Apart from this, chemical analyses, most carefully conducted, of the results of various processes of deodorisation prove that none of them have thus far succeeded in precipitating or retaining fertilising matters held in solution, the only substances precipitated being those which are held only in suspense, and which would just as well have been retained by the mere mechanical process of filtering."

Corfield, 2nd Edition, page 222.—"All these processes do to a certain extent purify the sewage and prevent the pollution of rivers, chiefly by removing the suspended matters from the sewage; but they all leave a very large amount of putrescible matter in the effluent water, and, at least, all the ammonia contained in the sewage (sometimes they add to it.) The greater part of the phosphoric acid is precipitated by some of them, while they increase the hardness of the river water—a matter of great importance if the stream be a small one.

"The manures that they produce are in every case very inferior, as may be expected from the known value of the sewage constituents that can be precipitated. They have all failed in producing valuable manure, because the valuable constituent of sewage, *par excellence*, is the ammonia, which, of course, invariably totally escapes in the effluent water, and is lost to the manure. This shows the futility of all attempts to utilise sewage by precipitation alone."*

FILTRATION PROCESSES.

Filtration Processes.

The Committee proceed to describe some attempts which have been and are now being made for the purification of sewage by filtration; but before so doing it will be expedient to explain in a few words the chemical effect on sewage which a well-constructed filter may exercise.

Principle of System.

The object in view—considering simply the purification of sewage—is to arrest the suspended matter, and to subject all the organic matters, both suspended and dissolved, to a rapid process of oxidation; in fact, to convert the carbon of organic matter into carbonic acid, and the nitrogen into nitric acid and ammonia, all of which are soluble and inoffensive in water—at any rate so far as

* Treatment and Utilisation of Sewage: by W. H. Corfield, M.A.; 2nd edition. Macmillan & Co., 1871.

that water with these only in solution may be safely admitted into a running stream. In other words, the object is to determine the decomposition, so as to bring the organic constituents as rapidly as possible into the forms they would ultimately assume if they were left to decompose spontaneously.

The free oxygen always contained in the water of a running stream, in process of time, effects the decomposition and conversion of organic matter into the compounds—carbonic acid, nitric acid, and ammonia; and this conversion, combined with the subsidence of suspended matters, gradually purifies any river into which sewage may have been discharged.

A process of a similar kind may be effected in a well-constructed filter. The pores of the filter are filled with atmospheric oxygen, and the conversion of organic matter when the sewage is first introduced into it is rapid; but the oxygen is thereby soon exhausted, and in order that the oxidation may be efficiently continued, the filter must then be properly drained, to allow the atmospheric air again to have free access to its pores.

This is the only chemical action a filter can have; all its effect besides is a purely mechanical arrest of the suspended particles.

Filtering agents.

Experiments have frequently been made to determine the best filtering medium for sewage, and charcoal has been more than once tried because of the peculiar property it possesses of absorbing many times its volume of oxygen and other gases; but it must be borne in mind that charcoal will not act continuously in this manner, as its power of absorbing oxygen soon ceases.

Defects of system.

It is further obvious, from the above explanation, that continuous upward filtration, or continuous downward filtration, must necessarily be inefficient for the purification of sewage. It is essential that the purifier, oxygen, should have frequent and free access into the interior of the filter; but this is obviously impossible in upward filtration, when the effluent can only pass out at the top of the filter, but may be secured by downward filtration, if it be intermittent, so that the last portion of each dose of sewage sinks to the bottom of the filter, allowing the atmospheric air to follow it.

Weare's Patent. Trials at Stoke-upon-Trent.

Weare's Filtration Process.—The Committee proceed to give an account of their inspection of the filtrating process by Weare's patent, conducted by the Peat Engineering and Sewage Filtration Company, at the Stoke-upon-Trent Workhouse. Mr. E. Johnson, the general manager of the company, and Mr. Weare, the acting local manager, accompanied the Committee over the works, and fully explained the details of the process.

The Workhouse is capable of accomodating between 800 and 900 persons, but at this time it had 650 inmates, including men,

women, and children. The water supply of the whole establishment is abundant, and is derived from two wells and a large pond fed from the surface drainage of neighbouring lands, and the overflow of which is carried into the sewers.

The Workhouse is accommodated almost entirely with water-closets, and the drainage of these, and of the urinals, piggeries, two-horse stable, wash-houses, baths, and in fact all liquid refuse, with the rain water falling on the premises, and the overflow of the pond, are taken together to one outfall. Until recently, the whole of this sewage was discharged into cesspools, which were emptied from time to time, and the overflow from which drained into a canal adjoining. Proceedings were threatened for polluting the canal and creating a nuisance, which led to the adoption of the present system. The ashes of the establishment are kept separate from the solid refuse, for uses to be presently described.

The dry weather flow is about 10,000 gallons daily, which is increased in rainy weather to as much as 20,000 gallons; but the system of filtration does not profess to deal with the storm flow, but only with a certain quantity, indicated by the capacity of the receiving tank.

Description of Weare's System.

The sewage is first discharged into a depositing tank, 24 feet long, 12 feet wide, and 4 feet deep, where the fœcal matters and coarser suspended matters are deposited, and passes through a rough filter of coarse cinders and charcoal into a second tank, 12 feet by 12, and 12 feet deep. The second tank is two-thirds filled with the same filtering material—that is, it is filled up to the level of the floor of the first tank.

After leaving the second tank, the sewage passes into a chamber in which is placed a small filter or charcoal cage, which can be raised and replaced, or renewed, when required.

After passing the charcoal cage, the suspended matters are for the most part removed, and the sewage is conveyed to a second series of finer filters, three in number, called the deodorisers.

The first deodoriser is filled with a mixture of fine charcoal and washed cinders, which is packed between horizontal perforated plates of galvanised iron, so that the sewage on entering the filter spreads itself over the surface of the upper plate and is evenly distributed over the filter bed. The effluent is then passed through the second deodoriser, similar to the first but smaller in dimensions, and is finally passed through the third and last deodoriser, in which cokes ground to about the size of a pea are used instead of cinders.

The last filter is finer and more frequently renewed than the others, and at the bottom, instead of a perforated plate, a filter cloth is used, to prevent the finer portions of the charcoal from

Weave's system—description of process.

being washed away with the effluent water. The water thus discharged appeared to be remarkably clear.

The depth of the first deodoriser is ...		4 feet	6 inches.
„ of the second	„ ...	2 „	0 „
„ of the third	„ ...	3 „	6 „

So that the sewage passes through ten vertical feet of filtering material.

In any operation conducted on a large scale, it is proposed to do away with the necessity of a filter cloth, by filtering upwards instead of downwards in the last deodoriser.

From the experiments of the Rivers Pollution Commissioners, to be presently referred to, and from the observations already made, the Committee are inclined to believe that this suggested upward filtration will be inefficient.

The last deodoriser, is emptied and renewed every three or four weeks, and its filtering material is used in the second deodoriser.

The second deodoriser is emptied and renewed every six weeks, and its material used in the first.

The first is emptied every ten weeks and its contents emptied into the first or "fœcal" tank.

The chamber in which the charcoal cage is placed is cleaned out twice a week, the cage renewed, and its charcoal also emptied into the fœcal tank.

Finally, the fœcal tank is drained off and emptied once in eight months, and the whole of its contents taken out and carted to the manure manufactory in Stoke, being previously mixed up with a sufficient quantity of fine ash to ensure dryness for its convenient carriage.

The whole system of tanks are, or are proposed to be, in duplicate.

The contents of the fœcal tank, when brought to the manure manufactory, are placed under covered sheds, mixed with a certain proportion of soot to make the manure thoroughly dry, and watered with a mixture of sulphuric acid and ammonia to bring it up to a standard strength. It is then sifted, and the coarser parts ground, so as to bring the whole to a fineish powder, which is packed in bags and sold.

In this state it realises £4 a ton. In its coarse state, without the addition of soot and ammonia, its value, according to Mr.

Weare's estimate, would be about £2 a ton. The Committee did not observe any offensive odour, either at the manure manufactory or the tanks; in fact, a temporary hospital for inmates suffering from contagious diseases is erected close to the fœcal tank.

The charcoal is supplied by the Company, and the quantity used is about one ton per week. About the same quantity of cinders from the Workhouse, sifted and washed for this purpose, is also used. Thus 52 tons a year of charcoal, and the same quantity of cinders, are required for the purification of the sewage of from 650 to 700 persons, with an ordinary daily flow of 10,000 gallons.

The estimated yield of manure, with the addition of ashes, soot, &c., as above explained, is estimated at from 200 to 250 tons a year.

Estimate for Birmingham.

It is, of course, difficult to estimate the quantity of charcoal required to purify efficiently the present sewage of Birmingham by this process; but assuming the same amount per head as at Stoke, it would require 75 tons of charcoal and the same amount of cinders per day. The estimate of Mr. Johnson, the manager of the Company, on an analysis of the Birmingham sewage is 20 tons per day for each material. (See letter in Appendix X.)

Trials at Bradford.

The Committee are informed that the Corporation of Bradford, a town of 140,000 inhabitants, have recently handed over their sewage to this Company, the Corporation agreeing to erect the necessary works, the Company to take and purify the sewage. The efficiency of this system on a large scale will, therefore, soon be completely tested.

Analysis of Sewage.

Samples were taken of the raw sewage, and of the effluent water, at Stoke, and sent to the Borough Analyst for analysis, who reports as follows:—

Dr. Hill's Report.

Borough Analyst's Laboratory,
Queen's College, Birmingham,
September 11th, 1871.

To the Sewage Inquiry Committee.

Gentlemen,—

I have the honour to report upon the two samples of sewage forwarded me by Mr. Mathews on the 8th ultimo, one of which was marked (Raw Sewage) 935, the other (Effluent Sewage) was numbered 812.

Mr. Mathews informs me that the effluent sewage is the result of filtering the raw sewage through filter beds of coke and charcoal.

Dr. Hill's Report.

The raw sewage was dirty, dark-coloured, turbid from an unusually large quantity of suspended matter, and possessed of a very offensive odour.

The effect of filtration has been to remove, almost completely, suspended matters; but what is very unusual and remarkable in this case is that, with the exception of this removal, and the diminution, to a large extent, of the dissolved organic carbon and nitrogen, every other ingredient, except oxide of iron and alumina, is greater in quantity in the effluent than in the raw sewage; so that while the total dissolved matter in the latter is less than usual, it is greater in the former than in the latter.

I can account for this only on the supposition that the filters were charged with impurity which they had previously arrested, and that a comparatively weak sewage, percolating through them, dissolved an additional quantity of certain substances.

Mr. Mathews stated, when he sent the samples, that there had been a heavy storm just previously to collecting the samples for analysis; this would dilute and render the raw sewage much weaker than usual—which, as I have already said, I find it to be—and probably enable it to exert the solvent action I have suggested.

When sewage has been passed over land in irrigation, it is deprived of nearly all its ammonia, potash, and other manurial substances, by the agency of vegetable growth; but in this case of simple filtration, the ammonia, potash, and soda are all larger in the effluent than in the raw sewage. The increase of ammonia in the effluent sample is, no doubt, due to the oxidation by the charcoal filters of nitrogenous organic matter, just as the nitrates found in association with the ammonia are produced by a still more complete oxidation of the same animal element. I find no nitrates in the raw sewage, but a considerable quantity in the effluent—water a condition similar to that frequently produced by irrigation.

Regarding all the circumstances of the case, and particularly the fact that the samples were collected after a heavy rainfall, I am inclined to think that the character of the effluent water is exceptional.

The process of filtration has had the effect of removing all suspended matter and much of the dissolved organic matter, as well as the offensive odour of the raw sewage, and has thus rendered the liquid fit to be received into rivers without causing a nuisance; but it has not rendered it fit for drinking, nor has it removed the principal manurial or fertilising clements of the sewage, so that it might with equal, if not greater, advantage be used for irrigation after filtration than before that process, as it could not, like raw sewage with its suspended matter, choke the soil or deposit anything on the plants themselves.

Dr. Hill's Report.

RESULT OF ANALYSIS EXPRESSED IN

DESCRIPTION.	*Parts per 100,000.*		*Grains per imperial gallon.*	
	Raw Sewage.	Effluent Sewage.	Raw Sewage.	Effluent Sewage.
ANALYSIS OF DISSOLVED MATTERS :				
Organic Carbon	6·19	3·50	4·33	2·45
Organic Nitrogen	2·11	0·96	1·47	0·67
Ammonia	4·00	7·00	2·80	4·90
Nitrogen, as Nitrates and Nitrites ...	0· 0	2·76	0· 0	1·93
Total combined Nitrogen	5·40	9·48	3·78	6·93
Chlorine	4·96	7·09	3·47	4.96
Sulphuric Acid	6·55	16·56	4·78	11·59
Silica...	1·28	1·36	0·89	0·95
Oxide of Iron and Alumina	6·68	4·61	4·67	3·22
Phosphoric Acid	a little	a little	a little	a little
Lime	5·78	8·28	3·94	5·79
Magnesia	1·72	1·79	1·20	1·25
Potash	2·64	9·22	1·85	6·45
Soda	5·07	10·09	3·55	7·06
SUSPENDED MATTERS :—				
Mineral	67·70	0·0	47·39	0·0
Organic	55·10	0·0	38·57	0·0
Total Suspended Matters	122·80	0·0	85·96	0·0
Total Dissolved Matters	47·30	77·50	33·11	54·25
Total Solid Matters dissolved and suspended	170·10	77·50	119·00	54·25

I have the honour to remain, Gentlemen,

Your obedient servant,

ALFRED HILL, M.D., F.C.S.

The above analysis indicates that, although the system may be effective, at any rate on a small scale, for the separation of suspended matters, yet that it is possible, when the filtering medium is not renewed with sufficient frequency, for the effluent water to pass away with even more valuable elements than the raw sewage itself possessed, and this possibility is sufficient to create some doubt as to the intrinsic value of the resulting manure, since charcoal, although it may be usefully employed to mix with and lighten stiff soils, is not in itself a fertiliser.

The analysis also suggests the use of the process to arrest suspended matters in sewage previous to irrigation, and in fact it is about to be employed at Epsom for this purpose.

Charcoal Filtration.

Two extracts are annexed to further illustrate the process of purification of sewage by filtration—one from the *Medical Press*, of Nov. 2nd, 1870, describing an attempt to purify sewage by artificial filtration through charcoal, made at Uxbridge some years ago; the other an extract from the Rivers Pollution Commissioners' Report on upward filtration through burnt clay ballast, at Ealing.

Experiment at Uxbridge.

Medical Press.—"At Uxbridge an attempt was made to purify the sewage by subsidence and subsequent filtration through charcoal, before it was discharged into the river Colne. The sewage, which amounted to 135,000 gallons a day, flowed to the works by gravitation, and after passing into a subsiding tank about 50 feet long, 15 feet wide, and 4·5 feet deep, where the coarser solid matters were deposited, it was strained through a grating, and then filtered through twelve boxes of coarse vegetable charcoal, each 4 feet long, 2 wide, and 1 deep. There were two sets of these filters, which were worked alternately, and when the filter ceased to act, the charcoal, together with the solid matters, was removed and mixed with the town refuse, and sold for 4s. per cubic yard. The process was so imperfect that it was abandoned in the year 1857, in consequence of a motion to the Court of Chancery, for a breach of the injunctions granted in 1855, restraining the Local Board of Health from discharging sewage into the river Colne, 'otherwise than in a state deodorised and free from anything offensive.' The original sewage, at the time of our examinatian in 1857, contained 41 grains of solid matter per gallon, of which 6·75 were organic; and the filtered sewage contained 36 grains, per gallon, of which 5·4 were organic. The filters therefore removed about 5 grains of solid matter, of which 1·35 were organic."

Trial at Ealing.

First Report of the Rivers Pollution Commissioners, page 61.—"The process carried on at Ealing is as follows:—The sewage is received into two deposit tanks, each 64 feet long by 10 feet wide and 8 feet deep. These deposit tanks are divided each into five chambers by planks having small openings to admit of the passage of sewage water; in the fourth chamber a rough filter of gravel or burnt ballast is formed, through which the sewage passes by ascension. Between the deposit tanks and the first set of filter beds are two iron baskets containing charcoal closely packed; after passing through these baskets, the sewage is received into the first set of filters, and rises through 18 inches of burnt clay ballast, which is now used in preference to gravel and sand. The water then flows over the weir at the end of the first set of filters into chambers containing wire baskets filled with burnt clay ballast, and is led by iron pipes into the second set of filter beds, where all the heavier suspended matter contained in the sewage water is deposited, the liquid then rising through two feet of burnt clay ballast. The capacity of the deposit tanks, and of the spaces under the filter beds which are employed as deposit chambers, amounts to 17,500. The area of filters in the deposit tanks is 240 superficial feet; that of the first set of filter beds is 630 superficial feet, and that of the second set of filter beds is 1,000 superficial feet. There is thus a total area of 1,870 superficial feet, and the sewage in its transit passes in all through 7ft. 4in. of of filtering materials. The soil collected in the deposit tanks and filters is removed through cast-iron valves, placed thirteen feet apart, and drops into vaults below, and is afterwards mixed with the dust and ashes collected by the scavenger, and sold for manure. The process as thus carried out entirely

fails to transform the soluble putrescent organic matter into innocuous mineral compounds. This failure is due partly to the filters being far too small for the volume of sewage dealt with, and partly to the circumstance that the filtration is performed upwards instead of downwards. For efficient purification by filtration it is essential that atmospheric oxygen should have frequent and free access to the interior of the filter, a condition which is entirely excluded in upward filtration."

Other trials.

Attempts at purification by filtration have also been made at Coventry, Chelmsford, Birmingham, and other places, but up to the present time they have not succeded and have been invariably abandoned.

Objection to Filtration.

The same objections, in fact, apply to filtering as to precipitating processes. They may be usefully employed under favourable circumstances, and on a moderate scale, for clarifying sewage; but for Birmingham, the constant daily expense, the quantity of ingredients, the enormous bulk of the manure to be dealt with, its doubtful value, and the uncertain issue as to the satisfaction of the injunctions, seem to indicate the impracticability of such schemes, as far as present knowledge on the subject extends.

IRRIGATION.

Treatment of Sewage by Irrigation.

The Committee have now to consider the only other method yet known for purifying sewage—viz., passing it through the natural soil.

"Land is a natural filter, and, if the purification of sewage alone is contemplated, a comparatively small area, used simply as a filter bed, may suffice, if the filtration is intermittent, to purify sewage so as to allow of its admission into a running stream; but if it is also required to utilise the elements of fertility which the sewage may contain, a vastly larger area is necessary if the sewage is to be applied, so as to produce the greatest return in the shape of marketable crops without injuring the permanent fertility of the soil."

Utilisation of Sewage.

UTILISATION.—The Committee proceed first to discuss the latter method, where utilisation is the primary object, and the following questions then arise:—

Problems to be solved.

1.—Does ordinary sewage possess a manurial value sufficient to induce landlords or tenants to incur the expense, which is considerable, of laying out land for its reception by way of irrigation?

2.—Can it be applied continuously without injury to the permanent fertility of the soil?

3.—What area of land of a given character is necessary for the perfect utilisation of sewage of given quantity and strength, so that no fertilising element of the sewage shall be wasted?

Conflicting opinions of value.

In the present state of knowledge upon this question it would be presumptuous in the Committee to express any decided opinion on these points.

Chemists of the highest scientific attainments express absolutely contrary opinions, and engineers of the greatest eminence are equally at variance.

In this state of uncertainty, it is therefore of special importance, in dealing with the immense volume of sewage at Birmingham, to proceed with the greatest caution—at any rate, until some agreement be come to between the various scientific authorities.

Utilisation tested by experience.

In default of such agreement, the only resource is to turn to those places where the irrigation system has been adopted, and endeavour to ascertain the result of their experience; but in doing this it must be borne in mind that, with a few exceptions, all trials of irrigation are of very recent date.

Visits to Sewage Farms.

For the purpose of obtaining the necessary information the Committee have inspected the sewage farms of Warwick, Rugby, and Mr. Hope's model farm at Romford, and have also addressed a series of questions to the authorities of such towns as have already adopted the irrigation system.

The information obtained from their inspection of the sewage farms is as follows:—

WARWICK.

Warwick.—The population of Warwick is 11,000. It is a complete water-closet town, the number of water-closets being 2,400.

The sewage, amounting to a dry weather flow of 528,000 gallons daily, is pumped to a height of 65 feet, and conveyed to a farm of 135 acres of clay soil, situated about 1½ mile from Warwick.

The sewage of 11,000 persons utilised on 135 acres is at the rate of 85 to the acre; but the Borough Surveyor of Warwick is strongly of opinion that an acre of land of this description cannot properly utilise the sewage of more than 50 persons.

The cost of conveying sewage to the land, including pumping engines, has amounted to £10,085, and of laying out the surface for its reception, from £1 to £10 an acre, according to the nature of the ground.

The annual cost of pumping, exclusive of interest on capital, is £600.

The farm is managed for the Corporation by Mr. E. Pritchard, C.E., the Borough Surveyor, and is held on lease for 21 years from 1866, at a rent of £420 10s., or about 3 guineas an acre; and the total annual outlay, including interest on capital, coals, and all

expenses of pumping, rent, and all ordinary expenses in connection with the working of the farm, is estimated at £1,900.

The land is, for the most part, undrained, and in consequence of the stiffness of the soil the sewage runs over instead of through it.

Experience has shown that sewage can be more completely purified by passing through the soil, and it is now intended to drain the land thoroughly to an average depth of 3 feet.

Rye grass is grown on about 60 acres, and irrigated once a week, from 5 to 8 hours at a time. Five or six cuttings a year are thus obtained.

Cabbages, mangolds, potatoes, and other green crops are also grown, and a small proportion of cereals—oats and wheat; but little or no sewage can be directly applied to growing cereal crops. Wheat is not irrigated at all, and oats two or three times only during the season.

The experience of the Borough Surveyor is to the effect that no regular rotation of crops is necessary, because the sewage manure, which can be applied at any time and in any quantity, is, in his opinion, sufficient for the requirements of any crop; and further, that the land is generally improved by irrigation and the crops very satisfactory.

In the winter, it is usual to irrigate the fallows heavily, to manure the land for spring sowing; and in a hard frost the sewage may be thus purified without being turned on to, and injuring, the growing crops.

The farm comprises some old pasture, which is also irrigated, and which has produced this year a crop of hay, 3 tons to the acre; the aftermath was very good, and there was a prospect of another crop should the season remain fine enough, and allow of its being made into hay.

The sewage is applied to the land in a raw state, but in the opinion of the Borough Surveyor it is better first to separate the suspended solid matters. The sewage is not thereby appreciably diminished in strength, the liquid being the part which possesses the chief manurial value, while the solid matter remaining can then be separately made use of to mix with and lighten the stiffest portion of the land.

Without this separation, too, the coarser suspended matters are apt to form a deposit, which gives rise to an offensive smell, on the sides of the carriers, when, as is here the case, they are not lined with concrete or otherwise protected. This separation, however, is not of importance when fallow land only is irrigated, as, for instance, when it is thus applied in large quantities preparatory

WARWICK. to planting cereals; but the raw sewage cannot be applied beneficially to grass after the plant has attained a certain growth.

The garden attached to the farmhouse was also irrigated, and cauliflowers, cabbages, asparagus, parsnips, vegetable marrows, onions, leeks, kidney beans, beet, strawberries, tomatoes, and watercresses planted therein were growing luxuriantly.

When the system of irrigation with sewage was first introduced here, the neighbouring farmers were strongly prejudiced against it. Now, however, they would gladly use it themselves. The Borough Surveyor stated, from his experience, that this result may be generally anticipated, and is only a matter of time, and that farmers would be certain, sooner or later, to avail themselves of any opportunity of applying sewage to their land.

The introduction of storm water into the sewers is one of the greatest difficulties connected with irrigation. The Borough Surveyor stated that, in his opinion, for complete utilisation or purification, a separate system of drains for the conveyance of storm and surface water was indispensable.

The system of sewers at Warwick is, as usual, arranged to admit storm water, but the difficulty has been lessened by taking as great a quantity as possible by separate drains direct into the river.

The Borough Surveyor is further of opinion that purification of sewage on the smallest possible area, without regard to utilisation, might be effected, at any rate for a limited time; and that he could thus purify the Warwick sewage on much less than half the present area, by making one-third fallow and growing rye-grass on the remainder.

The arrangements for irrigation here seemed very good, and the farm altogether very efficiently conducted. There was no perceptible smell, and the effluent water appeared fairly purified. When the proposed system of drainage has been carried out, the state of the effluent water will doubtless be greatly improved.

The Borough Surveyor's estimate of the financial result of the present year is as follows:—

Crops sold	£666	
„ stored, valued at	765	
„ growing	640	
		2,071
Total outlay as above stated	...	1,900
	Profit	£171

RUGBY. *Rugby.*—The population of Rugby is 10,000, but about 8,000 only contribute to the sewage, the dry weather flow of which is estimated to be 202,000 gallons daily.

The Rugby farm is held by the Local Board of Health, on lease, for 32 years, 5 of which have expired, at a rent of £4 an acre. The quantity is 65 acres, so that the sewage applied is that of 123 persons per acre. RUGBY.

The sewage of the upper portion of the town is taken by gravitation to the highest point of the farm; that of the lower portion of the town, together with the tail water from the upper fields, irrigates 16 acres of the lowest part of the farm.

The land has been drained 4 feet deep at intervals of 20 yards, but when the irrigation was first applied the drains were stopped up. Experience has shown this to be a mistake, and they are now being reopened.

The cultivation for the present year has been as follows:—Oats, eight acres; wheat, thirteen; mangolds, turnips and carrots, six; and the remainder rye grass, five or six cuttings of which are obtained yearly. Last year there was a ready sale for rye grass, but more has been grown in the present season than can be disposed of. Wheat is not irrigated at all, and oats but little.

The sewage on the upper portion of the farm is received in tanks, and before passing over the land is roughly strained through perforated boards.

The solid matter remaining is periodically taken out and applied to the land. It is not considered a good manure as its value is exhausted by a single crop.

The usual difficulty is created by storm water, and in wet weather there is a greater volume than can be properly passed through the land.

This farm is not a type of what a sewage farm should and might be. There was considerable offensive smell caused, especially, by a deposit of solid matter on the sides of the carriers; and the state of the effluent water was unsatisfactory. It was, in fact, evident that much more land was required, especially in the lower part of the farm, for purification and utilisation.

Romford.—The population of Romford is 8,000, but about 7,000 contribute to the sewage, the ordinary dry weather flow of which amounts to 247,000 gallons daily. ROMFORD.

The storm and surface water is for the most part taken into the sewers, but a portion of it is discharged direct into the river Rom, by the old drains.

The Romford Local Board of Health being under an injunction restraining the further discharge into the river, purchased Breton's farm, for the purification and utilisation of their sewage by irrigation.

ROMFORD. The area of the farm is 121 acres, so that the sewage applied is that of 58 persons per acre.

The sewage is conveyed by gravitation to the lower part of the farm, about two miles from Romford and is there discharged into depositing tanks, of which there are two, used alternately, and from which it is pumped to a height of 25 feet, and conveyed thence to all parts of the farm, starting in iron troughs supported on wooden tressels, with a slight fall until they reach the surface of the ground, and then by carriers formed out of low earth-banks lined with concrete.

Mr. Hope's experiments, After the purchase of the farm by the Board of Health, it was taken on a seven years lease from September, 1869, by Colonel Wm. Hope, V.C., an ardent advocate of sewage irrigation, for the purpose of putting into practice his ideas of the most efficient mode of applying sewage to land, and of exhibiting to the public the results that might be obtained by such application.

The sewers, tanks, pumping engines, and iron troughs have been erected, at a cost of £4,300, by the Board of Health, who also bear the cost of pumping, which is estimated not to exceed £150 a year.

The rent paid by Mr. Hope is £2 10s. an acre for the land, and £600 a year, or £5 an acre, for the sewage, with the responsibility of purifying the whole, and holding the Board harmless from any actions for nuisance.

Mr. Hope has himself laid out the farm for the reception of sewage, and for this purpose swept away all hedges, ditches, banks, and trees, and constructed the concrete carriers as above described.

The ridge-and-furrow system of distributing the sewage is employed as follows:—The land is laid out in long beds, 30 feet wide, at right angles to, and sloping from, the carriers. Along the central line or summit of each bed, from which the surface falls gradually 15 feet on each side, is a narrow gutter or grip, into which the sewage is discharged by taps of a simple construction in the iron troughs, and by sluices in the concrete carriers, and a workman walks down the bed with a spade or iron plate in his hand with which he stops the flow of sewage at intervals, so that it then flows over the surface of the bed on each side of the grip.

The mud deposited in the tank is usually removed each day, and put upon the poorest portions of the land.

The farm, both in its character and position, is very favourable for sewage irrigation. The soil is very poor, light, and sandy, with a gravel subsoil, and requires a maximum amount of moisture, and its proximity to the London market enables Mr. Hope to farm it as a market garden, and thus, by a constant growth of rye grass and green vegetables, to obtain the most favourable pecuniary results from sewage irrigation.

ROMFORD.

About eighty-five acres of land above the level of the tank are drained from five to six feet in depth, at intervals of fifty yards, in such a manner that the water from the drains can be discharged again into the tank, if required, in dry weather, and so be pumped back again over the farm, or it may be discharged direct into the river.

Even under the favourable conditions described, Mr. Hope considers the quantity of land insufficient (although the amount of sewage applied is small compared with other sewage farms), and he is now negotiating for an additional eighty acres of adjoining land for the cultivation of cereals. With this addition the quantity of sewage applied would be that of thirty-five persons to the acre, which Mr. Hope considers a maximum amount.

His experience of the feelings of adjoining farmers, with reference to irrigation, is similar to that of the Borough Surveyor of Warwick. They were first prejudiced against it, but have been converted by seeing the quality and quantity of the crops produced. Mr. Hope irrigated a field sown with rye grass and mangolds, adjoining his own farm, with such a beneficial result that the tenant would now be glad to negotiate for sewage for his whole farm of 500 acres, and has actually applied for some during the winter when it can be better spared.

Mr. Hope has lately laid out a farm of 270 acres, at Halsted, on the Colne, for the sewage of 6,000 persons, which is at the rate of twenty-two to the acre. This farm is intended to be cultivated in the ordinary manner, not confined to the growth of green crops, as is usual in sewage farms. Irrigation will be applied to grow rye grass, cabbages, swedes, and other root crops for the feeding of farm stock, the manure of which will then be used to grow corn and other cereals.

Land required for Birmingham Sewage.

It is obvious that if the sewage of Birmingham is to be utilised by irrigation, the quantity is far too vast to be devoted to the exclusive growth of rye grass and vegetables for the Birmingham market. It must of necessity be used for ordinary farming purposes, and in this case, taking Mr. Hope's maximum estimate of the quantity that can be thus applied—viz., thirty-five persons per acre—a minimum quantity of 10,000 acres would be required for the utilisation of the present sewage of Birmingham.

It is scarcely necessary to add that all the operations on Mr. Hope's farm at Romford seem to be conducted in the most efficient and appropriate manner, and no care nor expense seems to have been spared to make this, what the Committee believe it to be, the "Model Sewage Farm."

The quantity per acre of the various vegetables grown is very large, and the quality undoubted, as is fully set forth in the Report of the British Association for 1870, which may be referred to for further particulars.

Some few instances may here be given of towns where landowners have deemed it their interest to utilise the sewage on their own property, and instead of placing every possible obstruction in the way of the disposal of the sewage, have come to some reasonable agreement with the Corporations, or other authorities, and undertaken under certain conditions to receive and purify it, thus:—

LEAMINGTON. *At Leamington,* with a population of 23,500, and volume of sewage amounting to a daily dry weather flow of 800,000 gallons, an arrangement has been made by which the Earl of Warwick will receive the sewage of the town for 30 years, paying therefor the sum of £450 per annum, and indemnifying the Board from any actions for nuisance. The sewage is to be pumped 120 feet, and the town undertakes to erect the necessary works at an estimated cost of £17,000, and bear the annual expense of pumping. Here the storm water is carried direct into the river by a separate system of drains.

MALVERN. *At Malvern* the sewage has been for some time received on land belonging to Lady Emily Foley, one of whose tenants undertakes to utilise and purify it on his farm. But in consequence of the increase of the population the present quantity of land is insufficient, and an extension of this arrangement is about to be made, by which Lady Emily Foley will allow the Board of Health to conduct the sewage on to another farm, the tenant of which also conceives it to be his interest to receive and purify it.

EXETER. *At Exeter* a company has recently taken a lease of the sewage for 25 years, and contracts to construct an intercepting sewer, and all necessary works for applying the sewage to land by irrigation. The sewer and works are estimated to cost £30,000, and are to become the property of the Corporation at the determination of the lease.

CHELTENHAM *At Cheltenham* also, where the sewage is utilised over 330 acres of land, 130 acres only belong to the Corporation, and 200 to adjoining owners, who pay a small yearly rent for the sewage.

Analysis of Replies. The replies that have been received by the Committee in answer to the series of questions addressed, as before explained, to the various towns, where the system of irrigation is adopted, will be found in Appendix IX.; but the following general analysis of them may here be given.

They appear to be unanimous on the following points:—

1. That the land improves greatly under irrigation.

2. That, as a rule, no complaints are made of nuisance arising therefrom. In the few instances in which nuisance has risen, it has been the result of carelessness in conducting the irrigation.

3. The health of the district where irrigation is carried on is not injuriously affected. Conclusions from Experiments.

4. Cattle thrive on the irrigated land, and no case of their being affected with entozoa has ever been heard of.

5. No other manure has been found necessary for the crops, and the produce, both in quality and quantity, is very satisfactory.

6. The water, after passing through the land, is purified in a satisfactory manner, and in one case cattle drink the effluent water.

With the object of arriving at some general conclusion on the number of persons whose sewage is applied per acre, and the actual quantity of sewage applied, the following table has been drawn out from the information contained in the replies received. Extent of Land required

Town.	Population contributing to Sewers.	Gallons of Sewage per head.	Daily dry weather flow. Gallons.	Daily flow in tons, at 224 gallons a ton.	No. of Acres Irrigated.	No of Persons per Acre.	No. of tons applied yearly per Acre.	Quality of Soil.	Crops Cultivated.	No. of years' experience.
Birmingham ...	345000	49	17000000	75900	...	...	...	...	...	...
Edinburgh ...	96000	...	...	...	250	...	...	Sand.	Rye grass & meadow.	123
Carlisle	31000	...	...	...	110	...	...	Alluvial.	Pasture.	11
Wolverhampton.	68000	37	2500000	11160	...	...	...	Loamy clay, peat, and sand.	Rye grass.	1
Cheltenham ...	40000	25	1000000	4464	330	121	4937	Clay.	Pasture.	2
Bedford	16800	36	600000	2680	130	129	7520	Deep soil with gravel subsoil.	Rye grass and vegetables.	4
Bury...	15000	10	150000	670	26	577	9400	Light with gravel subsoil.	Rye grass.	6
Warwick	11000	48	528000	2357	135	81	6372	Clay.	Rye grass, vegetables pasture, and small quantity of cereals.	3½
Banbury	11500	26	300000	1340	130	90	3760	Stiff soil.	Rye grass, roots, and oats.	4
Rugby	8000	25	202000	902	65	123	5065	Gravel upon clay subsoil.	Rye grass, vegetables, and small quantity of cereals.	5
Romford	7000	35	247000	1102	121	58	3324	Light with gravel subsoil.	Rye grass and vegetables.	2
							7)40378			
							Average... 5768			

In reasoning upon these figures for our present purpose, the consideration of Edinburgh and Carlisle must be omitted, because a portion only of the sewage is in these cases applied to the land, the quantity and time of application depending on the convenience of those using it, and the remainder being allowed to flow unpurified into the sea. Wolverhampton must also be omitted, as there the system is not yet developed.

Comparison of Tables.

Taking the remaining seven, and looking at the column which is supposed to indicate the number of persons whose sewage is applied to an acre, the immense difference, ranging between 58 at Romford and 577 at Bury, will be at once observed.

It is, in fact, impossible to draw any conclusion from these figures, because the proportion of excreta, or chief manurial element which is actually discharged into the sewers, varies so greatly in different towns, and is, in many cases, impossible to determine.

Looking at the next column, which gives the number of tons actually applied, a considerable, but not so great, a divergence will be observed. The number of tons that may be applied for perfect utilisation (if we suppose a ready market for any crop that may be grown) depends—

1. Upon the capacity of the soil for absorbing moisture.
2. Upon the character of the plant grown thereon.

Kind of Crops raised.

Experience has shown that more sewage can be utilised (with the above condition) by the cultivation of rye grass than with any other plant; and green vegetables come next in order.

The quantity of sewage applied at Bury is far the greatest, and here rye grass is the only crop grown; and the land is so absorbent that there is actually no effluent water.

Land required for utilisation.

The average number of tons applied yearly per acre in the case of the last seven towns given in the table, is 5,768, and the staple crops are rye grass and vegetables. Applying this average to Birmingham, we get the area required for the utilisation of the sewage, with these particular crops, to be 4,800 acres.

But it is manifestly absurd to suppose that an area of this extent could be devoted to such a system of farming. It is necessary to consider not only what the land will produce, but also what demand there will be for the production. And if there is a difficulty in disposing of the rye grass now grown on our small experimental farm at Saltley, how much greater would be the difficulty when this crop is grown on a number of acres to be reckoned by the thousand?

It is therefore obvious that if the sewage of Birmingham is

to be utilised, it must be applied to ordinary farming. In this case the 4,800 acres must at least be doubled; and the result of Mr. Hope's experience, which, as before stated, would give a minimum of 10,000 acres for Birmingham, is thus approached.

Cost of preparing Land.

The cost of laying out the surface for the reception of sewage has varied from £1 to £23 per acre, according to the nature of the ground. A thorough drainage is also necessary, which can not be estimated at less than £10 an acre, so that £25 per acre may be roughly taken as the average cost of preparing land for irrigation.

Disposal of Storm Water.

With regard to the universally acknowledged difficulty of dealing with the storm water, it may be observed that at Leamington and Bedford it is separated from the sewage proper by a system of double drainage, and so passes directly into the river; at Warwick, also, a great portion is thus diverted by the formation of subsidiary drains.

Financial results of Sewage Farms

As to the general financial result of sewage farming, it is to be regretted that so little information has been obtained, the questions on this point having been generally unanswered.

The only two replies received are to the following effect:—

At Warwick, as before stated, the estimate for the present year (which has been the most satisfactory one) shows a profit of £171.

At Cheltenham the loss, after paying interest and yearly repayment of principal for purchase of land and permanent works, is almost nominal, but Cheltenham, as before remarked, is somewhat favourably circumstanced, for out of the 330 acres of land irrigated 130 acres only belong to the Corporation, and 200 to adjacent owners, who pay a small yearly rent for the sewage.

There is no doubt that large crops have been grown and sold for considerable sums per acre, but this by itself is no indication of profitable financial results; the expense which has been incurred for their production must be also known, and the silence on this head leads to the conclusion that, up to the present time at least, the general financial results have not been satisfactory. It might be otherwise if it were possible to rent or purchase suitable and conveniently situated land at its ordinary agricultural price, but this in the case of a Corporation is rarely possible, and when land, asserted to have a more than agricultural value, is purchased by compulsory powers, which often involves paying at least double, and always involves paying far more than its market price, and when, in addition to this, costly works are required to convey the sewage, and great expense in laying out the surface and draining, it would be quite unreasonable to anticipate anything but loss, though the sewage may in itself possess considerable manurial value.

Purification of Sewage.

INTERMITTENT FILTRATION.—The second branch of the irrigation principle has now to be considered—viz., the possibility of purifying sewage on the smallest possible area of land without any regard to its utilisation.

That purification of sewage by simple filtration through land is possible is already sufficiently proved, not only by the experience on sewage farms where the bare fallows are heavily irrigated, but by the well-known fact, already referred to in the first part of this Report, that the well waters of this town, as well as of all midden towns where water is obtained from surface wells, is very little else than filtered sewage.

Such water may not with impunity be used for domestic purposes, but the fact remains that it is so used, and is of course sufficiently purified to be admitted into a running stream.

Filtration Sytem.

The Committee were led to entertain the possibility of purifying sewage by filtration through a limited area of land by the extensive and interesting experiments, lasting over a considerable time, instituted by the Rivers Pollution Commissioners, for the purpose of ascertaining what description of soil made the best filtering medium, the amount of sewage that could be purified per cubic yard of such medium, and the best manner of conducting the filtration.

Report of River Commissioners.

For a detailed account of these experiments reference must be made to the first Report of the Commissioners, vol. 1., page 62-70; but as it is of the first importance that the conclusions to which they point should be fully known, a summary of the observations of the Commissioners thereon is here given.

"The experiments show that the process of intermittent downward filtration effects a very satisfactory purification of sewage when the sewage treated amounts to 5·6 gallons per cubic yard of filtering material in twenty-four hours, but becomes uncertain and unsatisfactory when the rate of filtration is doubled. The experiments also show that the process of purification is essentially one of oxidation, the organic matter being to a large extent converted into carbonic acid, water, and nitric acid; hence the necessity of the continual aëration of the filtering medium, which is secured by intermittent downward filtration, but entirely prevented by upward filtration."

Again, "The experiments upon the filtration of sewage through various materials, leave no doubt that this liquid can be effectually purified by such processes, and that probably any variety of porous and finely-divided soil may be employed for this purpose. The experiments also appear to show that if the soil be not overdosed with sewage, it will retain its efficiency for a long, if not an unlimited, period of time, and its pores will not become clogged up. With a properly constituted soil, well and deeply drained,

nothing more would be necessary than to level the surface, and to divide it into four equal plots, each of which in succession would receive the sewage for six hours. In this way the sewage of a water-closet town of 10,000 inhabitants, could, at a very moderate estimate be cleansed upon five acres of land, if the latter were well drained to the depth of six feet. Nevertheless, these are three formidable objections to the general adoption of this process—

Objections to Filtration on a small scale.

"1. It is entirely unremunerative, the amount of sewage applied to a given area of land being probably, in such a case, too great to permit of the growth of any ordinary agricultural crop.

"2. The whole of the manure ingredients of the sewage would be absolutely wasted.

"3. The collection of solid fœcal matters upon the surface of the soil, with no vegetation to make use of them, would probably give rise to a formidable nuisance, especially in hot weather."

These objections will be presently considered.*

Inquiries as to result of experiments.

The figures of the Commissioners above quoted, applied to the population of Birmingham, give 175 acres as the quantity of land which would be sufficient to purify the sewage of the borough by intermittent downward filtration.

Dr. Voelcker, in his report to the Public Works Committee, suggests that an acre of land may be made to purify the sewage of 1,000 people; and, on this scale, 350 acres would suffice.

The Committee considered it essential to gain as much information as possible on the possibility of putting into practice, on a large scale, this system of purification. They considered that the opinions, on this subject, of practical sewage irrigators would be most valuable, and accordingly, when at Romford, requested Mr. Hope to report to them thereon.

The Committee have also inspected the works at Merthyr Tydvil, constructed by Mr. Bailey Denton, C.E., to purify the sewage on this principle; and as this town is the first, and at present the only place, where the principle has been introduced, the Committee considered that Mr. Denton's opinion, founded upon this experience, would be particularly valuable, and accordingly requested him to report upon the possibility of applying the same to the sewage of Birmingham.

Mr. Hope's report, the information obtained at Merthyr Tydvil, and the report of Mr. Bailey Denton, are set forth successively as follows:—

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* See page 94.

MR. HOPE'S REPORT.

Thomas Avery, Esq.,
Chairman of the Sewage Inquiry Committee.

8, Finch Lane, London,
11th September, 1871.

Birmingham Sewage.

Sir,—In accordance with your request, I now have the honour to report, or rather to offer a few remarks, upon the proposed utilisation of the sewage of Birmingham, but in doing so it is well that I should repeat at the outset what I stated verbally to you on Friday last—that I am not personally acquainted with the neighbourhood of Birmingham, and that therefore any opinion which I may now offer is subject to such modification as any special circumstances, unknown to me, may necessitate.

Just as a counsel's opinion has no great value unless accompanied by the "case" submitted to him, so my opinion will, I presume, carry no great weight unless accompanied by a statement of the explanations given to me. I am informed that:—

Conditions of problem.

1. The population of Birmingham is about 350,000.

2. There are about 80,000 houses, of which 4,000 are provided with water-closets, and 76,000 have common cesspools and ashpits, the overflow from which finds its way into the sewers.

3. It is proposed to abolish the existing cesspools and ashpits, and to substitute some kind of impervious privies, to be emptied periodically, which are intended to receive, however, only the fœces and that portion of the urine voided simultaneously.

4. The total volume of sewage escaping from the town daily is estimated, after the above reform has been carried out, at 17 millions of gallons, or 75,892·8 tons.

5. The sewage is already concentrated—or the major part of it—into one outfall.

6. The Court of Chancery has ordered that, after an early date, no sewage shall be discharged into the river in such a way as to cause a nuisance, no matter what the difficulty or what the cost.

7. The land around Birmingham is very expensive, and exorbitant claims are set up, on imaginary foundations, when any attempt is made to purchase land under compulsory powers.

8. About 1,000 acres can be obtained in one direction, very much in a ring fence, at a comparatively moderate price, and commanded in level by the outfall sewer.

9. The farmers of the district are entirely ignorant alike of the theory and of the practice of sewage irrigation.

10. By the apparently eccentric Act of Parliament under which alone the Corporation can act in the matter—the compulsion of the Court of Chancery notwithstanding—the assent of the general body of ratepayers, in public meeting assembled, is required to any important expenditure of public money.

Complexity of the problem.

In view of the fact that it is therefore not only a legal, an engineering, a chemical, and an agricultural problem, but also a question of general expediency and practical business, I am asked whether, in my judgment (and in ignorance of the local topography), a sort of half-measure may be adopted, and a tentative irrigation scheme attempted, by which the sewage may be applied in the first instance to, say, 1,000 acres, until it can be seen whether some arrangement can be come to with neighbouring landowners and farmers by which the town may be saved the apparently ruinous expense of purchasing under compulsory powers, land, portions of which may be stated by the owners to have value for building purposes.

Partial Utilisation impracticable

To this I at once reply, without hesitation, that no such scheme is practicable. Sewage utilisation by irrigation is, when once set in motion, only a special kind of farming, and it cannot suceeed unless carried out in accordance with the physiological necessities of the crops and the commercial necessities of the farmer. Tried by these two tests, any attempt to UTILISE 17 millions of gallons of sewage daily upon a thousand acres of land, or upon any such quantity, can only end in complete failure and utter disappointment.

What then can be done?

Filtration suggested.

Again guarding myself by repeating that I do not know the locality, I would venture to suggest that, having regard to all the circumstances of the case, the most judicious and expedient course would be to use, say, three-fourths of the contemplated thousand acres for "intermittent downward filtration," as suggested by Professsor Frankland, and as experimentally carried out by my friend, Mr. Bailey Denton, at Merthyr Tydvil; and that the remaining 250 acres should be used as a model farm for the instruction of the neighbouring farmers.

Filtration sufficient for some years.

I feel no doubt that a half-measure of this sort, *well and carefully carried out*, would satisfy the Court of Chancery *for several years*, more especially if the water of the river is not used lower down for drinking; as, indeed, I presume, from its present foul condition, it must long have ceased to be. A respite of "several years" would place the town in a very much better position for making a permanent commercial arrangement for disposing of the sewage, for sewage farms are springing up in many places now, and the subject is daily attracting more and more attention in the agricultural world; while, of course, the model farm would be a practical school for the farmers in the neighbourhood. I should also be very happy to allow those of the farmers whose land might be within reach, and who were seriously thinking of taking sewage, to come to my farm, and I would give them a course of instruction.

Construction of Carrier for Sewage.

As regards the practical carrying out of this temporary half-measure, I would suggest that the sewer conveying the sewage from the present outfall to the thousand acres contemplated should be of the cheapest possible description, because, from what I gathered in casual conversation on Friday last, it seems to me very doubtful whether the entire volume of the sewage will be taken permanently in that direction. Concrete is, in round numbers, half the price of brickwork, and if properly made is much more durable, and is also absolutely impervious, which brickwork is not. Moreover, as the greater part of the work can be executed by ordinary labourers instead of skilled bricklayers, the work can be pushed forward much more rapidly, which I imagine will also be an advantage in the case of Birmingham. I should therefore recommend concrete as the material of construction.

Crops to be grown on part of the Land.

Mr. Bailey Denton informs me that he is at present treating only 600,000 gallons a day of the Merthyr Tydvil sewage, and that out of this the solid matter has previously been extracted; but, on the other hand, he has as yet used only ten acres out of the twenty, and in spite of this enormous concentration of sewage, has been able, by ridging the land up, as if for potatoes, to grow cabbages upon the land, which were sold at a price that brings in a return upon the total outlay. But it is obvious that what is possible on 10 acres during a few months, may be quite impossible over 750 acres for a lengthened period. I have *no doubt* that on some portions of the 750 acres crops might be grown, and if the convenience of farmers were suited the crops might doubtless be sold as cattle food, and would probably fetch £20 an acre or more; but what portion of the 750 acres could be treated in this way it is impossible to say without actual trial, for indeed, without sinking many pits in different parts of the land, to a depth of, say, six feet, and examining the section passed through, it is impossible to form any idea of the capacity of the land as a filter. Moreover, I should strongly dissuade the Corporation from going to the expense of extracting the solid matter. This would simply be another and troublesome operation, and if they go to the cost of buying 1,000 acres and constructing a sewer to it, much the cheapest and best plan will be to let everything flow on to the land. This will do any crops that it may be possible to grow no harm, because they must necessarily be grown on ridges such as the Committee saw on the low land at my farm, and this solid matter would therefore not injure them by clogging the pores of the soil in the immediate vicinity of their stems and roots. But on the other hand, it would not do to allow this solid mater to be exposed on the surface of the ground in hot weather in constantly accumulating quantities. Therefore it would be necessary to, what is called, scarify the land in between the rows of plants. There would be no difficulty in constructing an implement to be used by steam ploughing engines, which would thoroughly smash up and mix the land in between the rows, and so deodorise the solid matter of the sewage without injuring, in any way, the plants or the roots. All that would be necessary would be that these ridges should be further apart than usual—say, from 3 to 4 feet. If this is done, it is very possible that during the growing season green or root crops might be taken off the whole of the 750 acres proposed to be laid out as a filter; but the Committee would need to regard this in the nature of a windfall. On careful considera-

tion, I believe that these crops could really be grown; but what I wish to convey is, that the Committee must place the sanitary question above the agricultural, and at any time, if they find that it is necessary to do so, they must at once give orders to smash up the land regardless of the crops.

Arrangement and use of the Filtering Bed.

The 750 acres of filter should be divided into three divisions, or perhaps four, of as nearly equal sizes as possible, so that the whole of the sewage may be applied to the third or fourth part during 24 hours at a time, so that the land may have a rest for aëration during the interval.

In a temporary scheme of this kind, it will be necessary to arrange the land for the reception of the sewage *by night* as well as by day; and in view of the enormous quantity of liquid to be poured on to the limited area of 750 acres, the filter will need to be drained at a very much greater expense than is usually the case in agricultural land. It must be drained six feet deep, and very closely indeed. The pipes also must be larger than usual. Without knowing the levels of the land and many more topographical details, I cannot give an estimate for the cost of drainage, but it would be very heavy by comparison—perhaps £20 an acre. 17,000,000 of gallons a day is equal to a water supply of 48·8 gallons per head of the population of 350,000. These, which are the figures given to me, are obviously round figures; but I presume that they are tolerably close approximations. Now, supposing that we apply the sewage of 40 persons per acre on the model farm of 250 acres, this would absorb the sewage of 10,000 of the population, leaving 340,000 for the 750 acres of filter bed, or at the rate of 453 persons per acre. This would give 13,748 square inches per person per annum; or, in other words, it would give a FRESH AREA of land of only 12 inches in length, by a trifle over 3 in breadth, for the reception of the 48·8 gallons of sewage arriving each day in respect of each of the inhabitants. Or, to take it in another way, 17,000,000 of gallons per diem, less the sewage of the 10,000 persons applied to the 250 acres of model farm, being equal to 73,888 tons, would give a total depth of sewage over the whole 750 acres of filter, after deducting roadways, carriers, &c., of, in round numbers, about one inch each day in the year, or of no less than 30 feet 5 inches in the course of the year; but, concentrated upon a third or fourth part of the area each 24 hours, this would give a depth of sewage to be applied to the land of 3 or 4 inches on every third or fourth day.

Effect of Sewage upon Land.

Now, I have made a great number of careful experiments in the application of sewage to land, and I find that from 40 to 110 tons is sufficient to moisten the surface of an acre of land under ordinary conditions, and that the average dressing on my farm, including applications in winter, when my object was simply to filter the sewage, not to utilise it, and also including applications to crops ridged up as I have described, and to freshly-ploughed land, absorbing maximum quantities of sewage, has been only 200 tons per acre, or 2 inches in depth; consequently, 3 inches every third day, or 4 inches every fourth day, would be a severe tax on the filtering capacity of the land. It would not sink away for many hours, and in time it would necessitate so much reaëration—or, to put it chemically, reoxidisation of the land—that it is quite possible the Committee

would find themselves reluctantly compelled to plough up fine crops of cabbages or mangold-wurtzel. At the same time, to the extent to which such crops acted, they would, of course, *assist the soil* alike in purification, absorption, and evaporation.

Probable duration of the Filtering Bed.

In order that the Committee may better understand the enormous strain that they would be putting upon the purifying powers of the land, I may mention that the sewage applied to each acre of the 750 acres of filter would be equal, in ammonia, to some 10 or 11 tons of the best Peruvian guano, even after allowing for the interception of the solid fœcal matter from 76,000 houses, as proposed. Still I believe that if, as I said before, the river into which the filter will eventually drain is not intended for drinking purposes, the proposed filter and model farm together would effect a sufficient purification of the sewage, until such time as the farmers and landowners would be prepared to take it on reasonable terms. But of course, after a certain number of years, the top 18 inches or 2 feet of soil of the filter would become charged to excess with organic matter. On the other hand, it must be borne in mind that, at the end of the few years during which this filter might be used as a half-measure, the value of the land would be greatly increased. *How* much it is difficult to say, for we have no past experience to go upon, but I should think that for a 14 or 21 years' lease the value of the land might be increased by certainly 20s. an acre, perhaps as much as 30s. or 40s. This, of course, depends a good deal upon local circumstances and demand, about which I know absolutely nothing.

Increased value of Land per Annum.

In conclusion, I must beg the Committee to excuse any glaring errors of fact that I may have made as regards the circumstances and conditions of Birmingham, because they must remember that all I know about Birmingham is what I was told in casual conversation, on Friday, while walking over my farm, and that not expecting to be asked to write a report, I did not even take any notes, and have had to trust for my facts and figures to accidental recollection of what was told me in conversation; and further, that the greater part of this report I have not been able, from lack of time, to write in draft, but am obliged to send off as it was dictated, in order that I may keep my promise of posting it to-night.

I am, sir,

Your obedient servant,

W. HOPE.

P.S.—The Committee should bear in mind that, according to the present price of manures, the entire sewage of Birmingham must be worth something like £150,000. a year, and my experience teaches me that this, which is the intrinsic value of the manurial ingredients in the sewage, can, by proper management, be actually realised in practice. But it does not follow that the town will ever really get this value, for I am inclined to think that there are causes at work which will before many years produce a reduction in the market price of manures. It is true that guano is being exhausted, but this has set many ingenious chemists to work to discover new sources of manure, and several new sources are being developed. Besides

which, all previously known sources of manure are husbanded with greater care. But in addition to this, such vast tracts of land in the United States and the Colonies, as well as in some European countries, such as Hungary, are being brought into cultivation by steam power, and being connected with our markets by railways and steamships, that I am strongly inclined to think that the price of grain ten years hence will have been permanently reduced unless there has been a corresponding depreciation in the value of money, owing to the recent gold discoveries, or supposed discoveries. Another cause which would tend to lower the price of manure is the energetic efforts being made by Australian and South American colonists to preserve meat and send it to this country in a marketable condition, and it is obvious that if the farmer no longer receives the same price for his grain or his stock, he cannot give the same price for manure. But nevertheless, the Committee should bear in mind that at no distant day they ought to receive a very immense income from the sewage of Birmingham.

W. H.

Filtration experiments at Merthyr Tydvil.

The information obtained by the Committee from their inspection of the filtration works, at Merthyr Tydvil is as follows :—

Merthyr Tydvil.—The population of this town is 50,000, and the daily dry weather flow of sewage 600,000 gallons, or 12 gallons per head.

The Board of Health are restrained by the Court of Chancery from discharging their sewage into the river, and are making arrangements to purify and utilise it by irrigating 400 acres of land which they have secured for this purpose. It should, however, be stated, that this quantity of land had been taken before the efficiency of the method about to be described had been ascertained.

The method of purification at present employed is that of intermittent downward filtration on a limited area of land, arranged by, and carried on under the superintendence of Mr. Bailey Denton, C.E., appointed by the Court to see the injunction complied with in the interval which must elapse before the completion of the irrigation works.

Quantity of Land.

The area employed for the filtration is twenty acres, and, although not yet fully prepared, the whole of the sewage has been passed through it for the last three months.

It is intended to be divided into four beds of five acres each, receiving in succession the whole sewage continuously for six hours each per day.

Ten acres only, or two beds, are as yet completed, and these now receive, and have been receiving for the last month, the whole sewage for twelve hours each per day, amounting to about three inches daily over the entire surface of ten acres.

Character of Soil.

The soil is a fine, deep, friable loam, upon a gravelly subsoil, and is drained seven feet deep at intervals of forty yards, and the land is laid out in beds, divided by roads, with a gentle, regular inclination, and cropped with rye grass, various kinds of cabbages, mangolds, peas, and some other vegetables.

The drains run underneath the roads, so that the sewage cannot pass down directly into them with the risk of imperfect filtration.

When not under rye grass, the land is thrown into ridges and furrows, and on the crests of the ridges, three feet apart, the vegetables are planted, and are thus elevated above the sewage, which is run into the furrows between them.

Condition of Crops when Inspected on Sept. 13th.

The Committee observed that the crops were all in a fine healthy condition, the peas exceptionally so, as at this time of the year they generally fail under ordinary cultivation. All the vegetables had been planted since the 14th of June, and, from the information received, the growing crop had been sold, and realised an average of £17. 15s. per acre.

Money produce.

Five acres were in rye grass, sown in April; this had already yielded 2 cuts, realising together £12. per acre. The growing plant appeared very healthy, and was expected to yield in the present season a third cut at £6. per acre.

Although, as above stated, the 10 acres on which these crops were growing had for the last month received the whole of the Merthyr sewage, yet not the slightest offensive odour was given out, either from the land or the carriers, which, built of brick and cement, or of glazed earthenware, were most efficiently arranged for the even distribution of the sewage.

The sewage, which appears to be of the ordinary character, is mixed, before it enters the filtration works, with a small quantity of milk of lime, and then passed through a filtering tank, the filtering medium being crushed slag.

Some difficulty was experienced in disposing of the solid matter here separated, notwithstanding the fact that one farmer had grown luxuriant crops with its assistance.

Results upon Water.

The effluent water was in appearance most satisfactory, and when submitted to the test over white paper very favourably contrasted with that of the river, which, was stated to be not appreciably contaminated with sewage, though slightly affected by the drainage from the ironworks in the neighbourhood.

The following is a report on the state of the effluent water :—

Analytical Laboratory,
1, Victoria Street, Westminster,
London, 16th Sept., 1871.

Dear Sir,—I have carefully examined the sample of effluent water from the Merthyr filtering works, received from you on the 13th inst., and have obtained the following results, viz:—

	Solid Contents.			Nitrogen.	
	Fixed.	Organic.	Total.	As ammonia.	Organic.
Parts in 1,000,000...	340	50	390	0·688	0·185
Grains per gallon ...	23·8	3·5	27·3	·048	·013

These data suffice to show that the water is in a very clean condition and that it is quite fit to be admitted into the Taff. It is, in fact, cleaner than Thames water now is at Kingston.

Yours very truly,
(Signed) B. H. PAUL.

J. Bailey Denton, Esq.

Application of Filtration System to Birmingham: Mr. Bailey Denton's Report.

The Committee, impressed with the present efficiency of the works, their freedom from nuisance, the completeness of the filtration resulting from them, and the obvious capacity of works of this description for purifying for a period large quantities of sewage, requested Mr. Bailey Denton to furnish them with a report upon the practicability of applying a similar system for the purification of the sewage of Birmingham.

Mr. Bailey Denton's report is as follows:—

Report on Land in Tame Valley.

"REPORT on the fitness of certain lands for filtering the sewage of Birmingham on the principle of 'intermittent downward filtration' through natural soil.

"I.—I have inspected these lands, and find that the whole area is situated on the New Red Sandstone formation, and exhibits on its face several of its characteristics, including the red marl and sand beds (without rock) covered, more or less deeply, with drifted material and soil.

Quality of the Land.

"II.—The whole is capable of being made into filtering ground if the marls and clays are rendered porous by adequate under-drainage, deep surface cultivation, and a mixture with sand and burnt clay, if necessary. The more open sands and gravels will also require under-drainage, but of a different character, the only work necessary being such as will relieve the subsoil of water which would otherwise stagnate in it, and in wet seasons rise to the surface. The fewer drains that will effect this purpose the better it will be for the filtration, as there will not then be a too rapid passage of the sewage through the soil. There are very few portions which are either too stiff or too open in character

Drainage required.

for filtration, if the land is suitably prepared, and the application is properly conducted. It will be found, however, that there is a greater proportion of clay than has been expected. I mention this anticipation not from any fear of the clay resisting filtration, if properly prepared, but because the proportion of clay will govern the quantity of land required, and the cost of preparation.

Situation and configuration favourable.

"III.—The general configuration of the surface is favourable, and the cultivation of the land has not materially interfered with the natural slopes, by the formation of 'lands' or otherwise.

"IV.—But the drainage of the land is a consideration of equal importance with the suitability of the soil itself, it being necessary that there should be such a capability of discharge by the outfalls as will secure an adequate depth of filtering material to effect purification. That depth may vary, but the greater it is the less would be the surface required, and, *vice versâ*, the less the depth procurable the greater must be the area of filtering ground. Thus, with land drained at least six feet deep, every square yard of surface would command two cubic yards of filtering material; whereas, with land which can only be drained three feet deep, there will be but one cubic yard to the same surface space. Double the area in the one case will therefore be required compared with the other to purify the same quantity of sewage. The proportion of filtering material to sewage, too, must necessarily be governed by the character of the soil.

Quantity of Land required

"V.—I have not the information wherewith to determine what lands could be effectively drained with the existing outfalls, but, assuming that proper under-drainage can be afforded to a depth of at least six feet, I am of opinion that 900 acres will suffice for the purification of the sewage of Birmingham, with its population of 347,000, by intermittent downward filtration. This quantity of land is arrived at with a knowledge that the ordinary dry weather flow of the sewage from this population is slightly under 17,000,000 gallons daily, or about an average of 50 gallons per head, and that it may be augmented by surface influx to 20,000,000 gallons, which a provision of storm overflows would preserve as the outside limit of diluted sewage to be filtered. It is assumed that three series of filtering areas of 300 acres each are adopted, each of the three being sufficient to take the whole of the sewage at one time, and for a period—six or twelve months—which may be determined hereafter, leaving the other two series at rest in the interim. I am further of opinion that this arrangement may be made a lasting one, and will render the effluent water admissible into the River Tame without any nuisance whatever.

Experience at Merthyr.

"VI.—The experience at Merthyr justifies my stating that not only may crops be produced from the two series of areas which will be at rest, but that the series of areas at work may also be made equally productive.

"VII.—It may be desirable to show the farmers of the district what can be done with sewage in the way of ordinary irrigation, in which case 100 acres will probably suffice for the purpose, inasmuch as vegetables of a variety of kinds will be grown upon the filtering ground, and the mode of cultivation adopted will be equally instructive. **Model Farm proposed.**

"VIII.—If this arrangement should be carried out, 1,000 acres of land will suffice; but in order to secure this quantity at a suitable height, it may be requisite to purchase a larger extent, and either re-sell what may be inappropriate, or hold it to be worked in conjunction with the sewaged land.

"IX.—If you would forward me a plan with contour lines, of equal altitude at five feet differences of height, marked upon it, and connected with the height at which the sewage may be delivered on to the land, I should be able to tell you where the 900 acres required for filtration could be most advantageously taken. Should you, however, be satisfied upon this point without reference to me, I have only to reiterate my belief that you may with certainty carry into effect the principle of intermittent downward filtration for the purification of the sewage of Birmingham, if the work be appropriately designed and executed, and the subsequent application ofthe sewage be well conducted. **Filtration certainly effectual.**

"J. BAILEY DENTON.

"22, Whitehall Place, London,
21st September, 1871."

The following may be given as the general result of the investigations of the Committee on utilisation by irrigation, and on filtration through natural soil. **Irrigation and Filtration: Comparison of Opinions.**

On the one hand, Dr. E. Frankland, of the Royal College of Chemistry, and his associates on the Rivers Pollution Commission, and other scientific authorities, most strongly advocate the utilisation of sewage by irrigation. On the other hand, eminent chemists, such as Mr. George Shaw, whose opinions on this matter will be found in Appendix XI., altogether condemn the present water-carriage system; and yet these for the most part also believe that the only method of satisfactorily purifying the present volume of the Birmingham sewage is by filtration of some kind through land.

Again, the opinions of practical agriculturists at present tend to the conclusion that land is greatly benefited by sewage irrigation —(meadows at Edinburgh have been irrigated with sewage for upwards of 100 years)—provided it be applied in the proper manner, the coarse suspended parts being first separated for the irrigation of growing crops.

Moreover, all evidence at present tends to show that it would be the interest of agriculturists to take ordinary sewage and pay a reasonable price for it, provided their land could be readily laid out for its reception, and provided they were allowed to take it at the times and in the quantities they required. It is, however, doubtful whether, as a general rule, it would be profitable to a farmer to take ordinary sewage continuously, encumbered with the conditions of purifying it without creating a nuisance, and of passing it through his land at all times and seasons.

The same remarks would also apply to the sewage, even supposing the interception recommended by the Committee to be fully carried out. Its value would of course be diminished, as, also, the quantity of land required for its purification; but from the fact that land is frequently laid out, at great expense, for irrigation by water only, it is reasonable to infer that in any case sewage water would be very valuable to farmers at certain seasons.

Again, the evidence tends to the conclusion that a limited area of suitable land, properly laid out, can be made to purify large quantities of sewage, at least for a considerable, and, in the opinion of some, for an indefinite length of time—utilisation in this case being made entirely subservient to purification; and that the surface of such land, if the filtration be properly conducted, need not become a nuisance.

Opinions of Engineer.

In addition to the opinions which have been now given, on the principle of purifying sewage by filtration through land, the Committee considered it essential to take the opinions of some eminent engineer on the whole question of the disposal of the sewage of the borough.

Mr. Hawksley's Report.

They accordingly requested Mr. Thomas Hawksley, C.E., to act as their consulting engineer, and having laid before him the Reports of the Public Works Committee, of March 24th and June 6th, 1871, the details of water-closets and middens, and other information, requested him to advise and report upon the whole subject.

Mr. Hawksley's Report is as follows:—

"To the Special Committee appointed by the Council of the Borough of Birmingham for the purpose of reporting to the Council their opinion as to the best mode of disposing of, or dealing with, the sewage of the borough.

"30, Great George Street, Westminster,
September 25, 1871.

"Gentlemen,—In compliance with your instructions I have

now the pleasure to present my report on the several matters upon which you have done me the honour to consult me.

"1. I have made two visits to Birmingham for the purpose of conferring with your Committee and of making such examinations of the existing outfall sewage works and of the several localities hereinafter referred to, as, with the aid of the local knowledge acquired by me on the former occasions of my connection with this subject, should be sufficient to enable me to prepare a general report on the principal questions submitted to my consideration; and I have also had the benefit of the observations and advice of Mr. Fewtrell, F.C.S., an eminent analytical chemist, of special experience in the investigation and treatment of sewage waters.

Essential difference, in small and large communities, in conditions of Sewage Treatment.

"2. I must in the first instance solicit your attention to the significant fact that, notwithstanding the perfection to which the art of effecting the removal by water of excretal and other refuse of towns has in recent years attained, the problem of the most proper and most practicable means to be adopted for the repurification of the polluted liquid remains at present for the most part unsolved. To deal with the sewage of small communities by any of the various known methods of deposition, filtration, precipitation, or irrigation, is in general a comparatively easy task, but when, on the contrary, the populations amount to scores or hundreds of thousands, or perhaps to millions, the difficulties and expenses become at once augmented into very undue, if not into absolutely impossible, proportions. Thus, for instance, the object which in the case of small communities lies within ready reach, and can be well attained at a cost of £1 per head, may not, in the case of large communities, be accomplished, if at all, without extreme difficulty, nor at an expenditure of less than £3, £4, or £5 per head. It cannot therefore be safely asserted that because a particular project or a particular method has been adopted and has succeeded in some district favourable for the purpose, it is necessarily feasible, or even capable of being introduced in another district, differing greatly in the magnitude of its population, and possibly also in its other more influential circumstances and conditions. To no undertakings of public utility does this remark apply so forcibly as in the case of local undertakings for the defœcation and utilisation of sewage by the process of irrigation, for the means which may be applicable and desirable for Rugby may be worse than infeasible at Manchester, and may be utterly impossible to the metropolis. With this knowledge, I shall endeavour to present to you a fair and unbiassed view of the important matter referred by the Council to your consideration, leaving to your judgment the inferences to be drawn from the facts I shall endeavour to place before you.

Population of Birmingham.

"3. The population of Birmingham has now reached 345,000, and for the purposes of the present investigation may fairly be taken at 400,000, in order to allow for the natural increase likely to occur within such reasonable number of years as a well-considered scheme of public utility ought to provide for.

Quantity of Sewage and Rainfall.

"4. The ordinary dry weather discharge of sewage already amounts to 17,000,000 gallons daily (Sundays excepted), or 50 gallons per head, and cannot therefore be prospectively estimated at less than 20,000,000 gallons, unless the steps hereafter suggested be adopted to diminish this certainly reducible volume. To this large, although not unexampled, quantity must be added occasional accretions from rain to the limited amount of one-fourth of an inch, or 40 gallons per head per diem, beyond which all rainflows may be considered to be of the nature of storm-waters, and as such to have become wholly unmanageable by any available systems of works and appliances. I believe, however, that in the case of Birmingham it is quite possible to reduce the ordinary discharge by quite ten gallons per head per diem—first, by the careful exclusion from the sewers of such unpolluted springs and streams as are capable of being diverted into other channels; and, secondly, by the proper suppression of the undue waste known to occur from the cisterns, closets, and taps supplied by the Waterworks. I shall, therefore, base my subsequent calculations on the reasonable supposition that the ordinary daily discharge from all sources will not hereafter exceed 40 gallons per head, and that the maximum daily discharge to be dealt with will not exceed 80 gallons per head. The ordinary daily quantity due to 400,000 people may therefore be taken to be 16,000,000 gallons, and the maximum daily quantity at 32,000,000 gallons.

Scale of Works equired.

"5. In general, however, the amount of rainfall upon which I have calculated will run off in about eight hours, or at an average hourly rate of five gallons per head, whilst, on the other hand, the midday flow of the ordinary sewage will not, under favourable circumstances, be sensibly less than three gallons per head. It will therefore be necessary, in designing a system of works, to calculate upon an average hourly discharge during moderately wet weather of fully eight gallons per head, being at the average rate for the eight hours period of 3,200,000 gallons per hour; and this calculation presupposes the existence of tanks of sufficient magnitude to equalise the still occurring irregularities of the discharge from the outfall sewer during this assumed period of eight hours. The rate of discharge thus estimated will be reached about 12 times per annum.

"6. From these approximations to actual conditions—for precise accuracy is obviously impossible—we determine that any conduits to be made for the purpose of transmitting the fluid from the outfall tanks to a distance from the town must be capable of conveying not less than 3,200,000 gallons per hour in order to comply with the terms of the earlier of the two existing injunctions so sufficiently as to avoid the further intervention of the Court on behalf of the complainant. Again, if the Council should determine to have recourse, even temporarily, to the use of some one or more of the numerous precipitating agents known to be capable of effecting the clarification of the water, it will still be necessary to make such complete arrangements of tanks and apparatus as will enable 3,200,000 gallons per hour to be effectively treated for eight consecutive hours.

"7. The method of defœcation now most commonly recommended is that of irrigation. It is, therefore, the method which claims my first attention. In the mode in which this method is usually suggested its purpose is twofold: 1st, to effect the purification of the fouled fluid, and, 2ndly, to accomplish a profitable result from the utilisation of the fertilising elements present, or supposed to be present, in the water applied to the soil.

Systems of Treatment: Irrigation.

"The first of these purposes is often, but not always, accomplished with tolerable success, so far as regards the matters held in suspension by the water; but as regards the dissolved matters the same degree of success is rarely attained, depending as it does upon a great variety of variable conditions, as, for instance, the character for the time being of the dissolved matters, the nature of the soil through or over which the water is passed, the temperature of the season, the activity or inactivity of the plant life, the amount of aëration and of oxidation and nitrification to which the fluid has been or can be subjected in its previous flow, or whilst in or upon the soil; and hence it frequently happens that although on one occasion the process may afford almost complete satisfaction, yet that on another occasion the observed results are more or less disappointing. Hence, too, opinions and experiences differ very widely with regard to the general utility of the process, and still more so with respect to the area of land necessary to effect the removal or chemical reduction of the offensive compounds. According to the views of one gentleman claiming an extensive practical experience, not fewer than 10,000 or 12,000 acres would be required for the purification and utilisation of the Birmingham sewage; whilst another gentleman, of equal reputation, would be content with 5,000 acres; and, again, a third represents that as little as 500 acres would be sufficient for the purification, if the utilisation of the fertilising elements for the purposes of profit is not to be regarded. In the midst of these widely varying statements, it is, however, possible to have recourse to a few broad and simple facts. In the first place, it is known to every attentive observer that the manifest pollution of streams and the fouling of their beds and banks by sewage is occasioned, not by the matters held in solution, but, on the contrary, wholly and solely by the so-called suspended matters; and, in the second place, it is equally well known that if sewage, previously clarified from all suspended matters, be admitted into a flowing stream, its dissolved organic constituents never cease becoming more and more reduced by non-putrefactive decomposition into inorganic compounds of the most common and innocuous type, such, in fact, as are usually found very abundantly in springs and rivers to which sewage water has never had the means of access. Moreover, the sewage of Birmingham is remarkably weak, the undissolved organic matter averaging only 7 or 8 grains per gallon, whilst the dissolved organic matter does not appear to amount to more than 5 or 6 grains per gallon, the average sewage of London and many other large towns containing about 30 grains of undissolved organic matter and 15 grains of dissolved organic matter, or three times as much as the

Varying estimates of Land required

Suspended matter in Sewage to be removed.

Character of the sewage.

Birmingham sewage. The Birmingham sewage, indeed, contains in its normal or unpurified condition not more dissolved organic matter than I have found in samples collected by myself of the effluent waters of the Croydon and other sewaged meadows, after such waters had undergone the irrigating process. In the case of Birmingham, then, we may fairly dismiss any apprehension that the sewage would return to a foul and objectionable state after its admission into the River Tame, provided only the crude sewage be previously freed by any available means from the noisome matters it holds in suspension.

Plan of Operations advised.

"This important object can be effected in many ways, but, having regard to the terms of the injunctions, in my opinion most economically and most satifactorily on the following plan, which assumes that, in obedience to the decrees of the Court, the Corporation will discontinue the use of the existing Saltley Works, so far as respects the detention and accumulation of depositable solids (the detritus of the roads alone excepted), and that they will also remove from the river Tame, above Hams Hall, the whole of the liquid sewage, and thus exclude the possibility of any obnoxious questions, similar to those upon which litigation has recently occurred, again arising. With this view, it will be advisable to construct a conduit, of about 7½ miles in length, to convey 3,200,000 gallons per hour, from the outfall of the Saltley Sewage Works to some suitable tract of land situated in the Valley of the Tame, and lying well to the north of Hams Hall, and, preferably, a little south of the hamlet of Blackgreave. In this vicinity, and for a considerable distance north and east, the land consists for the most part of a light, sandy loam, intermixed with a small but loose gravel, and possessing very generally a tolerably regular surface of moderate and manageable inclination. This land is therefore eminently well adapted by nature for a sewage farm, but, in order to make it available for the reception and defœcation of the largest possible quantity of sewage, it must be thoroughly and closely under-drained, and be properly laid out for the production of grass crops only, and this without reference to the realisation of farming profits. Employed under these conditions, a comparatively small area of this land would be found adequate to the sufficient oxidation of the liquid sewage, especially during that period of the year in which alone it would be necessary to apply the liquid in large quantities to the soil, but provided always that the grosser particles of the floating organic matters be first removed.

"The course I venture to recommend for the consideration of the Committe is, therefore, the following:—

Description of Carrier.

"1st. To construct a main brick conduit of ovoid form, and and with a vertical diameter of 7 feet, and a horizontal diameter of 5½ feet, and having an effective declivity of 1 in 3,520, commencing at the present outfall works, and thence passing on the north side of the Tame Valley, and terminating at a point about half a mile north-west of the village called Hams Ford, and at an elevation of

270 feet or more above the datum of the Corporation maps, where proper receiving tanks may be established, and whence pipes of distribution may be sent off in various directions, but more particularly to about 1,000 acres of land lying between Whitacre and Kingsbury.

System of Depositing Tanks.

"2nd. To establish at these tanks a simple but effective system of deposition of such small quantity of suspended organic matter as shall have escaped a previous oxidising action during its course through more than seven miles of conduit in contact with air, and with a surface velocity of nearly 2½ feet per second. To facilitate the separation of the solid matter, I should recommend the addition (at Saltley) to the raw sewage of a small quantity of a cheap sulphate of alumina, and afterwards, at any convenient place in the length of the conduit, the addition, if needed, of such small quantity of the milk of lime as would be sufficient to occasion an alkaline reaction. The water thus treated would become perfectly clear in the receiving tanks, and might be thence turned into the river Tame without afterwards occasioning any offence; but for the sake of greater certainty, the effluent water may be used upon the land suggested to be purchased, especially during hot weather, and also at any other time when its use would be agriculturally beneficial. As it is, however, probable that a large proportion of the sewage would be eventually used voluntarily by farmers having land adjacent to the conduit, only a comparatively small quantity would possibly remain to be put upon the acquired land, or to be otherwise dealt with by the Corporation, the whole of the extensive area of farming land, situated below the level of the conduit being of a character well suited for sewage irrigation, both in respect of the quality of the soil and of the easy and regular inclination of the surface.

Clarifying Sewage.

Use of Sewage to Farmers.

"3rd. The deposited matter, the amount of which will not be large, I propose, to remove and place upon the Corporation farm, and to plough it into the sandy soil with the least possible delay, so as to prevent any disagreeable emanation. Its removal for this purpose can be effected in water or by cart. Dealt with in this manner, there will be no resulting nuisance, whereas, in nearly all known instances the irrigation of land by uncleansed sewage water is found to occasion an exhalation more or less noisome from the organic matter retained on the surface of the ground, and on the stems of the growing plants, as well as to interfere with the healthy development of the vegetation, and of course also with its commercial value.

Capacity of proposed Receiving Tank.

"8. The receiving tanks should contain, in the aggregate, about four hours' maximum flow of the ordinary sewage. This will rarely amount to more than one million gallons per hour. I therefore propose the construction of four tanks, each capable of holding one million gallons. As no sand will enter the conduit, the withdrawal of the deposit, by means of water or pumps, as the occasion may require, will not be a matter of any difficulty.

"9. The plan thus proposed will command at least 6,000 acres of land by gravitation, and much more by moderate pumping lifts, to be established if and when a sufficient demand for the agricultural use of the sewage should arise.

Saltley Works ill-adapted to their purpose.

"10. It will not escape remark that the simple means thus recommended might be well brought into operation at the Saltley Sewage Works, or at any substitutes for them, wherever placed, and at a comparatively small expense, if only the arrangements and appliances were made more suitable than they now are. The liquid sewage, as it passes from the outfall channel, is only faintly odorous, and might easily be rendered entirely inodorous. The 'sludge' raised from the tanks and placed on the ground to be dried is, however, exceedingly disgusting and passes very rapidly into a condition of putrefactive decomposition, giving off offensive gases, the odours of which sometimes pervade the atmosphere for no inconsiderable distance around. If, however, these tanks were to be enlarged to proper dimensions, and were to be properly covered in, and if the sludge were pumped and immediately consolidated, and then removed, either by railway or canal, in closed tanks or other closed vessels (proper docks or sidings, or both, being made to facilitate the operations), and if also the small remaining portion of the organic matter suspended in the water were to be carefully separated from it prior to its admission into the river, no just cause of complaint would, in my judgment, continue to exist, or would probably have been at any time alleged. "The sewage works, as now existing, are, however, without any of the apparatus, appliances, and conveniences necessary for conducting the business of clarifying the sewage, and of removing and utilising the deposit in that unobjectionable manner which I have reason to believe is perfectly practicable.

Cost of proposed new works.

"11. It is not easy to estimate the expense of a projected undertaking without the aid of accurate surveys and detailed drawings, but I am of opinion that the cost of the suggested conduit, tanks, and machinery, and the draining and laying out of a farm of 1,000 acres, inclusive of compensations and other contingencies, will not exceed the sum of £201,000, but exclusive of the price to be paid for the purchase of land, of which I do not profess to be a competent judge.

"12. I may further observe that if any objection should be entertained to the clarifying process being carried on in the situation indicated (a situation remote from population), that process can be equally well effected in many other positions; my only reason for placing it in the suggested locality being that this locality affords a convenient point for the ready distribution of the purified liquid over a large area of suitable land, situated in a very thinly-peopled district.

Conclusion.

"13. In conclusion, permit me to ask your attention to the necessity for diminishing, as far as circumstances will permit, the injurious practice of admitting strongly acid liquors into the sewers of

the borough, inasmuch as sewage water cannot in general be usefully or effectively dealt with, unless it exists in or is brought by a chemical operation into a neutral or slightly alkaline condition; and to add, that if the proposal of the Committee to abolish middens and to substitute the methods (but in an improved form) in use at Manchester, Rochdale, Hull, and other places, for the reception and removal of fœcal matter be adopted by the Council, the offensiveness of the sewage, and the trouble and expense of effecting its defœcation by any of the accepted methods, will be greatly diminished. The structural arrangements of the town of Birmingham certainly offer more than usual facilities for this purpose. On the other hand, should the Council resolve to convert Birmingham into a closeted town, the quantity of fœcal matter in the sewage will become increased more than ten-fold, and, if the statistics supplied to me be even approximately correct, to almost twenty-fold. There is, however, no instance in which the defœcation of sewage containing so vast an amount of fœcal matter—the fœcal matter of 350,000 people—has been as yet attempted, whether by irrigation or otherwise; nor is it possible from any existing experience to predicate what may be the pecuniary and sanitary difficulties to which the attempt to accomplish this object might ultimately lead. Of one important fact we are however assured, namely, that the strongest legal obligations imposed by the Legislature and enforced by the Courts of Law and Equity will necessitate the acquisition from time to time, and at any cost, of greater areas of land and of larger operations, until the effluent water shall at length regain from any extreme of pollution that high standard of purity which, according to modern views, is necessary to render it legally admissible into any public stream.

Concurrent remedies.

"I shall have much pleasure in replying to any further enquiries with which you may honour me,

And am, Gentlemen,
Your most obedient servant,
T. HAWKSLEY.

The following supplementary report from Mr. Hope has also been received:—

"8, Finch Lane, London,
"27th September, 1871.

Mr. Hope's Second Report.

"To Thomas Avery, Esq.,
Chairman of the Sewage Inquiry Committee of the Birmingham Corporation.

"*Birmingham Sewage.*

"Sir,—When I wrote my report the other day, I did not know that elaborate plans had been sent in to the Corporation, together with reports from so many distinguished persons, with whom I was virtually placed in competition; but a friend sent me, yesterday, a copy of the recent report of the Public Works Committee, and after reading it, I think it right to supplement my

report by some farther remarks, which, indeed, to some extent, I had intended at all events to have done.

"1. I omitted to state in my report that I myself have practised intermittent downward filtration, in winter, when the ground was fallow, on plots D and H on the accompanying map;* and that I applied no less than 6,000 tons per acre to H in ten weeks in November, December, and January, which is at the rate of about 31,000 tons of liquid per acre per annum. It is true that there is a vast difference between ten weeks and a whole year. But still they were the ten worst weeks in the year, and, notwithstanding, the result was that the sewage was perfectly purified, and the land so fertilised that, despite its natural poverty, it has produced one of the finest crops of onions ever seen. These figures, as regards plot H, I had not worked out when I wrote my report; and I now recommend the scheme of a big filter, combined with a model farm, with complete confidence, because it must be recollected that plot H had not been specially prepared either in drainage or in laying out as a filter.

Filtration recommended.

"2. Various areas are named in the reports attached to that of the Public Works Committee, as the most suitable for the thorough utilisation of the sewage, from 1,645 up to 8,000; but they are all utterly insufficient really to UTILISE the sewage of 350,000 people; that is, to enable the farmers to pay to the town the *full and real* value of the manure. It will necessarily be some years before that can be obtained; but it must not be supposed that the £150,000 a year, which is probably the intrinsic value of the sewage, could be obtained until the sewage has been distributed over some 20,000 acres of land, or more. This estimate of £150,000 a year, which I hazarded before, is, I am glad to see, fully borne out by the analyses of Dr. Voelcker and Dr. Hill; and I agree with the remarks of the latter gentleman as to the iron. The schemes proposed, therefore, though enormously expensive, would fail to return to the ratepayers anything approaching to the income which they ought, some day, to derive from the sewage.

Area of Land required for Utilisation.

"3. It is manifest that the extraordinary and bewildering number of areas suggested in the reports to the Public Works Committee cannot be *all* judicious. There must be a minimum area necessary as a filter for purification, and there must be a minimum area necessary for the thorough utilisation of the sewage; and *all other figures must be wrong*. The smallest area recommended is too large for the one, and the largest area recommended is altogether too small for the other. Moreover, if scientific men are called in as experts, to frame a scheme for the disposal of the sewage of a town, they should not, in my judgment, suggest a number of radically different schemes, and throw upon those whom they are called in to advise the responsibility of selecting the best;

Public Works Committee's Report: Errors in figures.

* The map referred to is not annex to this Report, but it may be stated that the plot D is about 13, and H about 10, acres.

but they should take upon themselves the responsibility of saying which scheme is, having regard to all the circumstances of the case, the best scheme to recommend the town to carry out, as a practical piece of business.

Utilisation by Corporation inadvisable.

"4. But it may perhaps be doubted whether anyone except myself, has ever considered, from a practical commercial point of view, as well as from a scientific point of view, how the sewage of a large town is to be disposed of, with a profit to both buyer and seller, during each of the 365 days in the year; how, in short, so great a machine is always to be kept usefully and remuneratively employed. It will be remembered that the views expressed on this point in the reports alluded to, are of the haziest description. Particularly, the Corporation are advised, after purchasing a great tract of land, on no account to farm it themselves, but simply to lay it out, and then to lease it to farmers and market gardeners. Admirable advice, no doubt, in the abstract; but how are tenants to be got immediately for 6,413 acres of sewage farms, or even for 1,645 acres? I see in one place the Corporation are specially advised not to dictate to the tenants—who, by the way, are only to pay a "nominal" rent—the quanties of sewage that they are to put on per acre. But the farmers of the district are at present profoundly ignorant of the whole subject, and might very likely in their ignorance create a fresh nuisance; and why should they be allowed laboriously to make their experience, while paying a "nominal" rent over a long term of years, when both they and the Corporation might get the benefit of the experience already gained and paid for?

Impossible to find Tenants.

"5. In my judgment, it would be perfectly and absolutely impossible to let several thousand acres of sewage farms with so short a notice; but it must be obvious to everyone accustomed to land and to farms—first, that if let at all, under such circumstances, only a "nominal" rent could be obtained for the sewage; and secondly, that in order to induce farmers to enter upon the farms, and go to all the risk and expense of moving, and of adopting what to them would seem so novel a mode of cultivation, the Corporation would need to secure them in leases of some duration, or in other words, would need to content themselves—after having gone to all the enormous outlay proposed—with that mere "nominal" return from the sewage, during a considerable number of years, at which they are advised to dispose of it.

Advantages of Filtration.

"6. I look all these difficulties fairly in the face, and having regard to all the circumstances of the case, I make a definite and precise recommendation, of which I accept the full responsibility. I say, do not waste your money in buying an area of land which, large as it is, would be quite insufficient to enable you to utilise all the manure of Birmingham; but buy only enough for a large filter, and supplement this by a small model farm, as a school for future customers, who will in a little time be very ready to buy all the manure you can sell them at a fair price. I say further, do

not let the laying-out of the land in one contract for a lump sum of money. You will do it cheaper by subdividing it into several contracts, and by doing part of the work yourselves, and dovetailing it in *with the cultivation* of the surface. You will thus do with deliberation, and therefore with due forethought and economy, that which you will infallibly be compelled, sooner or later, to do if you start upon the other plan. In fact, if you start on the assumption that you are to get tenants at once for all the land talked of, and with the determination not to farm it yourselves, you will get it into hopeless confusion, and find yourselves unexpectedly compelled, without any proper preparation, to undertake the farming of a huge tract of country, probably by that time covered with weeds; and we shall hear again of crops rotting on the ground because they have been grown without any provision for their consumption or disposal. For what are you advised to do? To grow grass enough for 8,000 cows; and ever so many other things besides. That is to say, as far as I can make out, to prepare the land through a contractor (and therefore at enormous expense, for contractors have no agricultural plant, and would have first to buy it, and then to sell it at a great loss), and to sow these crops, again through the expensive machinery of a contractor, in the belief that the owners of 8,000 cows are to come to Birmingham immediately, and to lease the land. But if they don't, what then? One of two things *must* happen. Either the Corporation must suddenly purchase 8,000 cows, for a trifle of, say, £200,000, or the grass must rot on the ground, or rather would have to be cut at the rate of 400 to 500 tons a day, and carted into heaps, where the stench would be so bad that it would have to be deodorised at great expense. This is no fancy picture, but a plain, sober statement of the inevitable result of want of careful calculation and consideration.

Comparatively small outlay required.

"But if the Corporation adopt my advice they can get into no such troubles. The capital expenditure in the first instance will be comparatively small, the model farm will be of reasonable and controllable dimensions, and I will undertake to provide them with a manager who shall bring them in some return for their money, after paying all working expenses; while the example set, being *a practical one*, and not starting with a break-down, would soon be followed by all the farmers of the district. It is also extremely probable that very little more money need be expended by the Corporation, but, at all events, no more need be spent in laying out other farms, as the farmers and landowners, by combination, can obtain all that they require for this purpose, just as they can for ordinary "improvements of land," from the "Lands Improvement" and other similar companies, at 4½ per cent. simple interest, and repayable over 25 years.

"Assuming that the 1,000 acres of land can be purchased for £100,000, and that the sewage can be conveyed to the land and the land laid out for another £60,000 (which ought to be ample), the annual charge against it would only be some £8 an acre, or only 10s. an acre more than I pay at Romford; so that there ought to be

no difficulty whatever in meeting the whole charge from the receipts of the land.

"In conclusion, I will merely say that I am ready, if so instructed, to prepare plans and estimates for carrying out such a scheme as I propose, as also to superintend the execution of the works, and that, having laboured so long and earnestly in the cause of sewage utilisation, I shall be mortified beyond measure if I see the first large town which adopts irrigation proceeding in the matter in a way that must involve a long period of confusion and loss before any good result is attained, and so again bring sewage irrigation into disfavour.

"I remain, Sir,

"Your obedient servant,

"W. HOPE."

Conclusion of Committee: Intermittent downward Filtration recommended.

After a careful consideration of all the facts and opinions now detailed—some of them necessarily contradictory, since much difference of opinion exists on the subject, and to enable the Committee to look at it fairly from all points of view, information has been obtained from all available sources—the Committee have come to the conclusion that the best method of dealing with the sewage of the borough is that of intermittent downward filtration on the smallest possible area of land, at the greatest convenient distance from the outfall, so as to command as large an area as possible for ultimate utilisation by farmers, and that 800 acres of suitable land are sufficient for the purpose. The calculations which have led the Committee to this conclusion are based to a considerable extent upon the present character and volume of the sewage, and are only partially influenced by the interception recommended in the first part of this Report, and the quantity which may ultimately be taken by owners or occupiers of land along the proposed line of conduit—two important considerations, which must to some extent, but to what extent it is at present impossible to estimate, reduce the pollution of the sewage and the quantity to be purified, and therefore the quantity of land required.

The Committee do not deem it expedient to make any great allowance on account of these considerations. The method of intermittent downward filtration is, like every other method, somewhat tentative; there is certainly no example of its success on so large a scale as that proposed, and no experience of the number of years for which the land will act as an efficient filter, although many think it will so act continuously. The quantity recommended will, in the opinion of the Committee, be sufficient to cover all contingencies.

With the information since given, the objections of the Rivers Pollution Commissioners, quoted on page 71 of this Report, can now be considered.

Objections of River Commissioners answered.

Instead of 175 acres, suggested by the experiments of the Commissioners (which, if these experiments could be absolutely relied on, would be sufficient to purify the whole sewage of Birmingham), or of 350 acres, suggested by Dr. Voelcker, the Committee propose, in accordance with the advice contained in the various reports quoted, to devote 800 acres of land to the purpose of purification; and this alone might be taken to be a sufficient reply.

But to the first objection they may also answer that the experience at Merthyr Tydvil, and at Romford, as shown in Mr. Hope's supplementary report, has clearly shown that rye grass and vegetables of various kinds can be grown on the proposed area. Even with this assistance, the Committee do not imagine that this or any other method of satisfactorily purifying sewage of the borough could at present, with existing local conditions, be made remunerative.

There might be some ground for the second objection as to the waste of manure ingredients, provided these ingredients could be profitably utilised by the Council themselves. But, in the opinion of the Committee, it would be most imprudent to make any such attempt.

The duty of the Council is to satisfy the present and avoid the risk of future injunctions of the Court of Chancery, at the least possible cost to the ratepayers, and not to embark in speculative schemes for utilisation of sewage.

The scheme proposed does not prevent, but, on the contrary, gives every possible opportunity to owners and occupiers to utilise the sewage on their lands; and if it is their interest to do so, as it is the interest of the Council to supply the sewage, they must in time take it upon terms which will be mutually advantageous. The purchase of land by the Council at a compulsory price, which being far beyond the agricultural value, leaves no margin for profit on cultivation, is therefore superfluous.

If, on the other hand, it should turn out that the sewage does not possess a manurial value sufficient to repay the cost of laying out land to receive it, then the acquisition of land for the purpose of utilisation would be a still more wasteful extravagance.

As to the third objection—viz., the nuisance that must arise from an accumulation on the surface of fœcal matter—the experience of Mr. Hope, at Romford, and of Mr. Bailey Denton, at Merthyr, combined with the opinions expressed by Mr. Hawksley in his report, show satisfactorily that this will not be the case if the filtration works are properly laid out and managed. Moreover, if, contrary to all this experience, any nuisance of the kind should arise, it must be ultimately brought to an end by the interception recommended in the first part of this Report.

Acquisition of Land.

The Committee, after having determined upon the principle of intermittent downward filtration, were anxious to secure (subject to the approval of the Council) the necessary quantity of land, in addition to the 140 acres now in the possession of the Council at Saltley, but the time at their disposal has been too short to enable them to conduct any negotiations for the acquisition of land.

From the reports already quoted, it is evident that there is abundance of land of a suitable quality in the Tame Valley; but the Committee are of opinion that it should be obtained, if possible, beyond the estate of Sir Charles Adderley, in order that the conduit may command the greatest possible area, and also that one, at any rate, of the existing injunctions may be satisfactorily and simply complied with.

Pumping Sewage.

The Committee have been unable, from want of time, sufficiently to consider the expediency of raising the sewage to a higher level. They had less hesitation in passing over this branch of the inquiry, as they considered it purely a question of utilisation, which, for the reasons already stated they do not consider to be the primary object of the Council. But they cannot dismiss the subject without expressing an opinion that ultimately—if irrigation is found to be the real solution of the sewage question, and a demand for sewage has been created—it may be found desirable to extend the irrigated area to higher land by pumping; as sewage irrigation produces much greater comparative results on such land, than on the lower and richer valley land, and the expense of pumping may in consequence be more than covered by the increased price obtained for the sewage.

Storm Water.

The serious question of the disposal of storm water has also engaged the attention of the Committee, and they regret that, in the opinion of the Borough Surveyor, the exclusion of any considerable portion from the sewers is impracticable. (See Report on this subject, Appendix IV.)

The Committee have not been able, with the limited time at their command, to give this portion of the subject the attention it deserves. It will be remembered that at Leamington and Bedford storm water is kept out of the sewers by a separate system of drains, and that in other towns it has been found possible to divert a portion direct into the rivers. The Committee are of opinion that the possibility of so diverting a portion of the storm water by the formation of some subsidiary drains, and, moreover, of excluding from the sewers and diverting into the river the contents of some old watercourses, deserves the serious consideration of the Council.

Offers of Companies, &c

The Committee have further to report that they have received offers to deal with the whole or portions of the Birmingham sewage from the A B C Company, the Phosphate Company, and the Peat Engineering and Sewage Filtration Company. These offers will be found in Appendix X.

The recommendations of the Committee to the Council on the preliminary steps to be taken, with a view to the purification of the sewage by intermittent downward filtration, are as follow:—

1. The purchase of 800 acres of land for the purposes mentioned in this Report.

2. To obtain borrowing powers for the purchase of land and execution of the necessary works.

3. To obtain powers for creating perpetual annuities for such sums as may be actually expended upon the purchase of land, and for distributing the repayment over 75 years of such sums as may be expended upon the construction of a conduit or other necessary permanent structural works.

4. To obtain powers for leasing lands and entering into agreements for supplying sewage to owners and occupiers of land.

CONCLUSION.

Estimate of Cost.

The Committee have now to give an estimate of the cost of carrying into effect the propositions they have submitted to the Council. Such an estimate can, of course, be only approximate. but it is the result of careful consideration. It is as follows:—

CAPITAL ACCOUNT.

Estimated cost of conduit, tanks, machinery, and other appliances, and of draining and preparing 800 acres of land, inclusive of compensation and other contingences	£190,000
Add 20 per cent. for interest during construction of works, commission, and other charges for supervision, &c.	38,000
Draining land at Saltley, say 100 acres, 6 or 7 ft. deep, at £8. per acre	800
Cost of 800 acres of land by compulsory purchase, including Parliamentary charges, compensation, &c., &c., at £120. per acre	96,000
	£324,800

INCOME AND EXPENDITURE ACCOUNT.

EXPENDITURE.

4½ per cent. interest, including repayment of principal in seventy-five years, on	£190,000	
	38,000	
	£228,000	£10,260
Interest on £800 for draining land at Saltley, including repayment of principal in 17 years, being the unexpired term of lease, say 7½ per cent.		60
4 per cent. Perpetual Annuities on £96,000, the estimated cost of land		3,840
		£14,160

INCOME.

Balance of income over current expenditure, on filtration and cultivation of land, being £4. per acre on 800 acres for rent, use of sewage, and interest on expenditure in draining and preparing land ...	£3,200
Rate proposed to be charged on water-closets, say	3,000
Rent for sewage, estimated to be supplied from conduit	2,000
Economy to the borough from proposed system of weekly collection, being saving on sales of intercepted excreta	1,000
	£9,200

Estimated	Expenditure ...	£14,160
„	Income ...	9,200
„	Annual Loss ...	£4,960

Appointment of Special Committee.

The final recommendation of the Committee to the Council is as follows:—

That in case the Council adopt, in substance, the recommendations now submitted, and instruct this Committee to carry the same into effect, that the Committee be called "The

Recommendation of Committee.

Sanitary and Sewage Committee," and be empowered to prepare for approval by the Council the necessary measures to be submitted to Parliament and the Local Government Board, and cause the usual Parliamentary and other notices to be given, under the advice of the Town Clerk; such Committee to have the management and control of the sewers, sewage, and sewage farm.

The Committee have also to report that they have obtained the names and addresses of the owners, lessees, and occupiers of all the lands coloured upon the plan attached to the Report of the Public Works Committee of the 6th of June last, and also a valuation of the same from Mr. F. Willmot. They considered this necessary to guide them in selecting suitable land for the purposes of their own recommendations, and also to prevent, as far as lay in their own power, any occasion for delay in dealing with the whole subject, when their Report should be submitted to the Council.

Statements in Appendix.

The Committee have much pleasure in expressing their obligation to the many gentlemen who have communicated valuable information and suggestions in the course of this inquiry—especially to the medical gentlemen, whose communications are printed in the Appendix, and to Mr. George Shaw, Mr. Brooke Smith, Mr. J. Beckett, Mr. Edwin Chesshire, Mr. J. Houghton, Mr. C. F. Coterill, Mr. C. Chattock, Mr. A. Bird, Mr. J. Holmes, Mr. B. Standon, and Mr. A. Burbidge, jun. It is, of course, impossible for the Committee to annex to their Report all the statements which they have received, but they have given some of them in Appendix XI., and they have given all careful consideration.

Drainage Commission.

In conclusion, the Committee are of opinion that, bearing in mind the fact that a large and thickly-populated district outside the borough of Birmingham contributes by sewage to the pollution of the river Tame, it would be just and expedient that a Drainage Commission should be formed, elected by ratepayers of the whole district draining into this river. If, therefore, the Government should propose to form such a district, governed by a fairly-elected representative body, the Committee would strongly recommend the Council to accept and support such a proposition. But the Committee are of opinion that such a proposition must be introduced by the Government and not by the Council.

SUMMARY OF RECOMMENDATIONS.

1. The gradual abolition of middens and substitution of a new privy system, based upon the principle of exclusion from the sewers, and weekly collection of all excrementitious matters, solid and liquid.

2. A system, to be developed in connection with the above, of exclusion from the sewers and collection of refuse from slaughter-houses, cattle markets, urinals, cow-houses, and stables.

3. An experimental trial of the Rochdale and Manchester systems, on a sufficiently large scale, and under the strictest supervision; and ultimately an extension to the whole town of that system which shall be found to be the most efficient.

4. The imposition of a rate on occupiers, in respect of water-closets connected with the sewers, on a scale to be sanctioned by the Council.

5. That a register be prepared and kept up of all connections with the sewers, and that no future connections with the sewers should be made without the consent of the Council.

6. The exclusion from the sewers of the refuse from the works of German silver manufacturers, galvanisers, wire drawers, and manufacturing chemists, and from such other works the refuse from which may, from time to time, be found to interfere with the utilisation of the sewage of the borough, unless such refuse shall, previously to being discharged into the sewers, have been so treated as not to interfere with such utilisation.

7. The purchase of 800 acres of land for the purposes mentioned in this report.

8. To obtain borrowing powers for the purchase of land and execution of the necessary works.

9. To obtain powers for creating Perpetual Annuities for such sums as may be actually expended upon the purchase of land, and for distributing the repayment over 75 years of such sums as may be expended upon the construction of a conduit or other necessary permanent structural works.

10. To obtain powers for leasing land and entering into agreements for supplying sewage to owners and occupiers of land.

11. That in case the Council adopt in substance the recommendations now submitted, and instruct this Committee to carry the same into effect, the Committee be called "The Sanitary and Sewage Committee," and be empowered to prepare for approval by the Council the necessary measures to be submitted to Parliament and the Local Government Board, and cause the usual Parliamentary and other notices to be given, under the advice of the Town Clerk; such Committee to have the management and control of the sewers, sewage, and sewage farm.

(Signed) THOMAS AVERY, Chairman.
HENRY HAWKES.
ALFRED BARRATT, M.D.
JESSE COLLINGS.
WM. HARRIS.
JOHN LOWE.
EDMUND TONKS, B.C.L.

G. S. MATHEWS, M.A.,
Secretary.

Oct. 2, 1871.

APPENDICES.

APPENDIX I.

Borough Surveyor's Return of the number of Houses, Manufactories, Public Buildings, Stables, Cow-houses, Slaughter-houses, Water-closets, and Ashpits in the Borough.

RESOLUTIONS

TO BOROUGH SURVEYOR.

Nos. 5 and 13.

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5. *Resolved*—"That the Borough Surveyor be instructed to make a Return of the number of communications with the Sewers, distinguishing the houses, slaughter-houses, cow-houses, stables, and public establishments; and that, in the case of manufactories, he report the nature of the material passed from the same to the Sewers day by day, and, so far as he can, the quantity of such material; also to report the number of houses and other premises in the borough having water-closets, and also the number of water-closets in communication with the Sewers; and that he be authorised, with the Chairman's sanction, to employ assistants."

13. *Resolved*—"That the Borough Surveyor be instructed to ascertain and report to this Committee the number of privies and ashpits in the borough; and the number of them draining into the Sewers."

APPENDIX I.

BOROUGH OF BIRMINGHAM.

STATEMENT showing the Number of Houses, Manufactories, Workshops, &c., in each Street; also the Drains, Water-closets, &c., in communication with the Sewers *discharging at Saltley.*

REFERENCE TO WARD NUMBERS.

1. Ladywood. 2. All Saints. 3. Hampton. 4. St. George. 5. St. Mary. 6. St. Paul. 7. Market Hall. 8. St. Peter. 9. St. Martin. 10. St. Thomas. 11. Edgbaston. 12. Deritend. 13. Duddeston and Nechells.

Name of Street or Road. A	No. of Ward.	No. of Houses.	No. of Manufactories, Workshops, &c.	Number of Public Buildings.	No. of Stables.	No. of Cow-houses.	No. of Slaughter-houses.	No. of communications with the Sewers.	No. of Premises having W.C. draining into Sewers.	No. of Water-closets in each street.	No. of Ashpits draining into Sewers.	No. of Ashpits undrained.	No. of Ashpits covered.
Ann St., Waterloo St.	6 8	41	10	1	5	"	"	13	25	44	12	"	"
Albert St., Moor St...	8	4	"	"	"	"	"	3	"	"	"	"	"
Alcester Street.....	12	144	19	3	4	"	"	18	6	14	25	17	5
Adderley Street	12	105	7	1	9	2	1	19	3	14	16	4	4
Allison Street	9	196	11	"	10	"	1	15	"	"	22	10	6
A B Row	13	14	5	"	"	1	"	2	1	1	3	"	1
Ashted Row.....	13	237	30	"	26	"	6	73	9	9	69	43	15
Adam Street.....	13	112	7	"	5	"	"	7	"	"	9	4	"
Aston Road	13	318	58	2	27	2	5	57	11	12	67	36	10
Anderton Street	1	29	"	"	"	"	"	3	"	3	"	3	"
Albion Street	2	64	4	"	3	"	"	15	4	4	17	"	2
Aston Street.....	5	125	21	"	15	"	6	41	10	12	31	2	13
Ampton Road	11	20	"	1	14	"	"	18	17	32	13	4	11
Adelaide Street, Vauxhall Road...	13	70	"	"	2	"	"	4	2	2	4	7	2
Arthur Road	11	12	"	"	7	"	"	11	10	17	7	4	5
Albert St., Key Hill.	2	34	4	"	"	"	"	"	"	"	"	"	"
Augusta Street.....	2	47	28	"	1	"	"	22	5	6	21	6	26
Adelaide Street, Lombard Street..	12	92	2	"	3	"	"	8	1	1	12	2	"
Allcock Street	12	105	5	"	2	1	"	1	1	6	4	13	"
Ann Street, Nechells Park Road	13	9	"	"	"	"	"	"	"	"	"	"	"
Andover Street	8	5	1	"	"	"	"	3	2	4	1	"	"
Anderton's Road	12	52	"	"	4	2	"	"	"	"	"	"	"
All Saints Street	2	16	2	1	"	"	"	2	3	3	3	11	3
Augustus Road	11	29	"	"	6	"	"	29	29	77	29	"	11
Aberdeen Street	2	139	1	"	2	"	1	14	2	2	40	26	16
Alma Crescent.....	13	5	"	"	"	"	"	1	"	"	2	2	"
Angelina Street	12	137	7	"	5	"	"	26	"	"	22	18	5
Alston Street	1	47	2	"	"	"	"	32	7	7	32	14	1
Allesley Street..... ...	5 13	26	1	"	"	"	"	7	"	"	9	1	2
Aston Brook Street...	5 13	12	"	"	"	"	"	2	"	"	6	"	"
Avenue Road	13	65	4	"	5	"	"	"	"	"	"	"	"
Arsenal Street	12	17	"	"	"	"	"	2	"	"	12	"	"
Abberley Street	2	"	"	"	"	"	"	"	"	"	"	"	"
Abbey Street	2	46	"	"	"	"	"	"	"	"	"	"	"
Alexandra Street.....	1	19	"	"	"	"	"	"	"	"	"	"	"
Alma Street	4	"	"	"	"	"	"	"	"	"	"	"	"
Arthur Street	12	22	1	"	"	"	"	"	"	"	"	"	"
Armoury Road.....	12	"	1	"	"	"	"	"	"	"	"	"	"
Alexandra Road	11	4	"	"	"	"	"	1	"	"	3	"	"
All Saints Road	2	28	1	"	"	"	"	1	"	"	4	"	"
TOTAL ..	"	2447	232	9	155	8	20	450	148	270	495	227	138

1. Ladywood. 2. All Saints. 3. Hampton. 4. St. George. 5. St. Mary. 6. St. Paul. 7. Market Hall. 8. St. Peter. 9. St. Martin. 10. St. Thomas. 11. Edgbaston. 12. Deritend. 13. Duddeston and Nechells

Name of Street or Road. B	No. of Ward.	No. of Houses.	No. of Manufactories, Workshops, &c.	Number of Public Buildings.	No. of Stables.	No. of Cow-houses.	No. of Slaughter-houses.	No. of communications with the Sewers.	No. of Premises having W.C. draining into Sewers.	No. of Water-closets in each street.	No. of Ashpits draining into Sewers.	No. of Ashpits undrained.	No. of Ashpits covered.
Bennett's Hill	8	29	"	3	"	"	"	27	32	74	8	"	"
Bull Street	5 8	115	16	1	13	"	1	78	84	123	19	1	6
Bartholomew Row	8	36	16	"	1	"	"	5	"	"	8	"	"
Bull Ring	8 9	32	4	1	4	"	"	7	7	11	5	"	2
Bell Street	7	12	1	1	5	"	"	6	6	7	1	"	"
Beak Street	7	37	1	"	"	"	"	6	"	"	6	"	"
Bread Street, Hill St.	7	14	3	"	1	"	"	2	"	"	3	"	"
Bromsgrove Street	10 7 9	301	30	"	9	"	"	48	3	3	58	15	20
Bath Passage	7	13	14	"	"	"	"	6	"	"	"	6	"
Bishop Street, Masshouse Lane	8	9	2	"	4	1	"	10	"	"	7	"	2
Barford Street	9	276	49	"	8	1	"	20	"	"	19	2	4
Bartholomew Street	8	109	32	"	4	"	"	6	"	"	15	2	5
Bradford Street	8 12	342	73	3	35	1	2	85	29	45	92	31	13
Brewery Street, Newtown Row	5	41	2	"	3	"	"	9	1	1	7	"	9
Birchall Street	12	57	8	"	3	"	"	12	2	6	8	6	"
Bordesley Street	8 9	259	25	1	7	"	1	26	1	1	21	13	3
Barn Street	8	127	6	1	1	"	"	12	"	"	5	12	5
Banbury Street	8	25	4	1	5	"	"	10	2	4	8	"	"
Buck Street	8	33	5	"	1	"	"	7	2	4	5	2	"
Belmont Passage	13	28	4	"	2	"	"	3	"	"	4	3	"
Balsall Street	9	42	4	"	4	"	"	8	"	"	9	"	1
Blucher Street	10	117	10	1	1	"	"	16	1	1	17	2	6
Bath Row	10	153	11	2	12	"	1	30	7	17	45	29	4
Bishopsgate Street	10	236	9	"	10	"	"	19	1	1	22	5	3
Berkeley Street	10	16	8	"	3	"	"	8	6	20	2	2	2
Broad Street	10 1	43	32	1	7	"	"	34	33	58	11	2	10
Bridge St., Broad St.	10	4	5	"	5	"	"	6	1	4	7	3	4
Belmont Row	13	77	14	1	6	1	"	14	12	12	12	8	2
Barrack Street	13	12	"	1	"	"	"	"	1	1	"	2	"
Barford Street South	9	125	5	1	5	"	"	29	2	2	28	9	13
Bishop Street, Moseley Street	9	136	20	1	7	"	"	29	4	12	30	7	10
Broom Street	12	40	3	"	1	"	"	7	"	"	9	"	"
Bacchus Road	2	99	1	"	4	1	"	"	"	"	"	"	"
Bridge Street, Belmont Row	13	6	"	"	"	"	"	"	"	"	"	"	"
Bowyer Street	12	13	2	"	2	"	"	3	"	"	5	2	1
Bissell Street	9	180	27	1	6	"	"	29	2	3	27	7	9
Bear Lane	11	7	"	"	1	"	"	"	"	"	"	"	"
Barlow's Road	11	3	"	"	3	"	"	"	"	"	"	"	"
Brewery Street, Darwin Street	12	49	2	"	"	"	"	"	"	"	"	"	"
Barker Street	1	81	4	"	3	"	"	"	"	"	"	"	"
Belgrave Road	11 9	108	"	"	2	"	"	47	6	6	77	28	25
Bellis Street	11	77	2	"	2	"	"	14	"	"	26	"	2
Bridge Road	11	5	"	"	4	"	"	4	5	7	5	"	"
Bishop Street South	9	61	4	"	4	"	"	12	"	"	14	2	1
Baskerville Place	1	12	"	"	"	"	"	"	"	"	"	"	"
Bordesley Park Road	12	96	2	"	3	"	"	15	"	"	21	6	"
Blews Street West	2	70	"	"	2	"	"	"	"	"	"	"	"
Braithwaite Road	12	31	"	"	1	"	"	15	29	29	15	"	"
Baskerville Passage	1	1	"	"	3	"	"	"	"	"	"	"	"
Beaufort Road	11	45	"	1	6	"	"	45	45	70	40	5	13
Brueton's Walk	13	12	5	"	2	"	"	"	"	"	"	"	"
Blake Lane	12	"	"	"	"	"	"	"	"	"	"	"	"
Betholom Row	10	26	1	"	"	"	"	3	"	"	3	2	2
Bracebridge Street	5 13	84	3	"	1	"	"	13	"	"	9	5	3

1. Ladywood. 2. All Saints. 3. Hampton. 4. St. George. 5. St. Mary. 6. St. Paul. 7. Market Hall. 8. St. Peter. 9. St. Martin. 10. St. Thomas. 11. Edgbaston. 12. Deritend. 13. Duddeston and Nechells.

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B—*continued.*													
Bullock Street	13	10	1	"	"	"	"	"	"	"	"	"	"
Beswick Street	2	"	"	"	"	"	"	"	"	"	"	"	"
Beach Street	1	14	"	"	"	"	"	11	"	"	14	"	"
Brewery St., Heneage Street	13	106	3	"	"	"	"	7	"	"	"	17	2
Bloomsbury	13	155	21	"	"	"	2	45	2	2	41	42	3
Bread St., Livery St.	3 6	83	12	"	1	"	"	16	1	1	18	"	"
Bow Street	10	94	1	1	1	"	"	5	1	1	9	6	"
Benacre Street	9	269	22	"	3	1	"	41	2	4	41	15	17
Bell-barn Road	10 11	538	21	"	10	3	"	68	4	6	105	36	24
Bristol Road	11	195	2	"	80	2	"	136	82	102	103	76	60
Blews Street	5	121	5	"	7	1	"	11	"	"	10	1	2
Bristol Street	9 10	282	44	3	19	"	4	45	12	13	75	23	18
Balsall Heath Road	11	48	1	"	3	"	"	9	3	3	17	11	16
Branston Street	2	126	48	1	3	"	"	13	4	6	27	2	7
Bath Street	4	78	50	4	1	"	"	11	8	27	24	10	15
Bagot Street	5 13	130	16	1	6	"	"	22	"	"	18	4	7
Balloon Street	6	29	1	"	"	"	"	2	"	"	1	2	"
Brick-kiln Street	5	57	1	"	"	"	"	6	"	"	6	5	"
Brearley Street	4	301	33	"	5	"	1	30	1	13	25	1	3
Buckingham Street	3 4	135	30	"	2	"	"	10	1	1	16	3	10
Bond Street	4	21	3	1	"	"	"	2	"	"	3	1	"
Bridge Street West	4 3	393	27	"	10	2	1	42	"	"	35	27	21
Brearley Street West	4 3	284	38	"	7	1	"	15	5	9	14	34	25
Barr Street	4	190	49	"	4	"	"	35	2	2	30	16	16
Bloomsbury Street	13	183	15	"	10	1	2	43	3	3	61	11	4
Brook Street	2 6	9	5	"	1	"	"	9	5	8	5	1	2
Bedford Road	12	56	1	"	"	"	"	"	"	"	"	"	"
Brass Street	5	36	1	"	"	"	"	8	"	"	5	6	"
Burbury Street	3	136	8	"	4	"	"	29	1	1	21	8	10
Bread Lane	4	36	4	"	"	"	"	7	"	"	7	2	"
Barr Street West	3	99	25	"	3	"	"	20	"	"	27	7	11
Bailey Street	5	12	4	"	1	"	"	3	"	"	3	"	"
Brasshouse Passage	1	50	4	"	5	"	"	10	1	1	12	"	1
Bordesley Green	12	44	"	"	8	1	"	7	"	"	7	25	3
Branch, Sir Harry's Road to Ampton Road	10	"	"	"	"	"	"	"	"	"	"	"	"
Branch, Bellbarn Road to Bristol Road	10	"	"	"	"	"	"	"	"	"	"	"	"
Branch, Westbourne Road to Highfield Road	11	1	"	"	"	"	"	"	"	"	"	"	"
Branch, King Edward's Road to Crescent Wharf	1	"	"	"	"	"	"	"	"	"	"	"	"
Branch, Palmer St.	12	36	"	"	1	"	"	"	"	"	"	"	"
Branch, Hagley Road to Bear Lane	11	"	"	"	"	"	"	"	"	"	"	"	"
Brookfield Road	2	1	1	"	1	"	"	"	"	"	"	"	"
Brook Road	11	1	"	"	1	"	"	"	"	"	"	"	"
Beatrice Crescent	11	9	"	"	"	"	"	6	"	"	10	"	"
Berner Street	3	32	"	"	"	"	"	3	"	"	2	6	"
Bullock Road, Harborne Road	11	2	"	"	1	"	"	"	"	"	"	"	"
TOTAL	"	8364	966	33	413	17	15	1512	462	725	1525	623	466

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C													
Cannon Street	8	31	7	2	1	"	"	18	19	28	13	"	"
Colmore Row	6 83	26	10	2	3	"	"	6	20	40	3	"	"
Coach Yard	5	20	8	"	4	"	1	8	4	5	3	2	"
Cherry Street	8	49	"	1	"	"	"	21	26	40	3	13	"
Crooked Lane	8	2	3	"	2	"	"	5	5	6	5	"	"
Castle St., Moor St.	8	14	2	"	2	"	"	6	5	6	6	"	"
Carr's Lane	8	4	1	2	"	"	"	14	15	22	2	"	"
Chapel Street	8	26	2	"	"	"	"	7	1	1	13	"	1
Cross Street	7	84	13	"	3	"	"	11	"	"	14	"	"
Christ Church Passage	8	"	"	"	"	"	"	"	"	"	"	"	"
Chapel House Street	12	22	1	1	1	"	"	4	1	1	2	2	1
Camp Hill	12	124	4	2	4	"	2	39	5	5	67	6	14
Cheapside	9 12	524	59	"	20	2	5	65	5	22	66	19	25
Coventry Street	9	114	10	"	4	"	1	19	4	6	9	18	4
Cotton Street	8	35	"	"	"	"	"	1	"	"	"	3	"
Coleshill Street	8	202	60	1	7	"	4	60	14	13	64	11	23
Curzon Street	8 13	80	5	1	5	1	1	7	3	3	6	8	3
Communication Row	10	97	7	"	2	"	"	10	1	3	12	6	"
Cumberland Street	1	50	6	"	1	"	"	14	1	2	18	2	6
Cambridge Street	1	33	12	"	9	"	"	19	9	27	11	1	"
Congreve Street	6	38	"	"	4	"	1	18	19	22	10	3	4
Crescent	1	20	"	"	8	"	"	"	1	1	"	"	"
Camden Street	2	351	24	"	15	1	2	53	10	18	51	4	7
Cardigan Street	13	150	6	"	3	"	"	20	1	2	30	3	4
Coleman Street	13	134	2	"	"	"	"	12	"	"	8	9	6
Claverdon Street	13	114	"	"	"	"	"	10	"	"	27	1	1
Church Street	3 6	77	27	"	3	"	1	12	"	"	15	"	"
Constitution Hill	3	43	97	2	9	"	3	37	26	36	35	7	19
Charlotte Street	6	66	18	"	6	"	"	16	14	37	5	6	9
Canal Street	5	46	20	"	"	"	"	6	"	"	3	6	2
Cliveland Street	4	65	7	"	2	"	"	4	"	"	2	"	1
Cecil Street	4	168	38	"	2	"	"	20	"	"	21	2	9
Church Road, Edgbaston	11	17	"	2	12	"	"	16	18	50	17	"	5
Calthorpe Road	11	48	"	1	20	"	"	48	41	63	46	1	13
Chad Road	11	15	"	"	4	"	"	15	15	28	15	"	7
Cregoe Street	10	243	12	"	8	"	3	29	"	"	42	14	5
Chequer Walk	10	30	2	"	1	"	"	2	"	"	2	2	"
Crescent Wharf	1	7	3	"	9	"	"	"	"	"	"	"	"
Carpenter Road	11	33	"	1	19	"	"	37	41	61	33	3	7
Cox Street	3 2	82	10	"	2	"	"	10	"	"	13	6	11
Caroline Street	2	73	45	"	5	"	1	20	14	28	14	33	31
Carver Street	2	216	26	"	7	"	2	36	"	"	43	1	11
Charlotte Road	11	42	"	1	14	"	"	32	36	38	32	6	6
Charles Henry Street	12 9	321	33	1	6	"	1	47	1	2	63	19	18
Cattell's Grove	13	49	2	"	1	"	"	1	"	"	1	17	"
Clement Street	1	56	15	"	4	11	"	21	3	9	16	"	6
Cheatham Street	13	18	1	"	1	1	"	3	"	"	9	1	"
Cranemore Street	13	21	1	"	1	"	"	"	"	"	"	6	"
Claybrook Street	9	27	4	"	1	"	"	6	"	"	6	"	"
Castle Street, Lower Dartmouth St.	12	9	"	"	"	"	"	"	"	"	"	2	"
Cromwell Street	13	420	21	"	15	2	3	60	"	"	87	46	12
Cherry Wood Lane	12	4	"	"	1	"	"	"	"	"	"	"	"
Coventry Rd. (part of)	12	259	16	2	15	1	4	92	5	7	111	2	11
Cope Street	2	52	5	"	"	"	"	9	1	1	2	"	"
Chester Street, Ladywood Lane	1	184	7	"	1	"	"	32	"	"	40	1	2

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C—*continued.*													
Clark Street	1	172	1	"	2	1	"	10	"	"	15	"	"
Cato Street	13	92	4	1	4	"	"	11	4	4	21	10	1
Cape Street	2	6	"	"	"	"	"	1	"	"	2	2	"
Carlisle Street	2	17	"	"	"	"	"	2	"	"	2	9	"
Church Rd., Nechells Park Road	13	39	"	"	1	"	"	"	"	"	"	8	"
Cato Street North	13	71	2	"	"	"	"	19	"	"	34	8	"
Charles Arthur Street	13	91	1	"	"	1	"	"	"	"	"	"	"
Cuckoo Lane	13	17	"	"	"	"	"	"	"	"	"	"	"
Cathcart Street	13	33	"	"	"	"	"	2	"	"	3	14	"
Conybere Street	12	128	4	"	2	"	"	8	"	"	8	17	1
Chester Street, Dartmouth Street	13	10	5	"	5	"	"	2	1	1	2	5	4
Camden Drive, Camden Street	2	"	"	1	"	"	"	4	"	"	3	"	2
Coplow Street	1	22	"	"	1	"	"	"	"	"	"	"	"
Clarendon Road	11	6	"	1	1	"	"	4	6	10	6	"	1
Camp Street	12	30	"	"	"	"	"	4	"	"	10	"	2
Cattell Road	12	275	2	"	7	"	1	38	"	"	88	22	16
Clissold Street	2	53	2	"	1	"	"	1	"	"	4	"	1
College Street	2	71	"	"	"	"	"	5	"	"	9	"	"
Commercial Street	10	8	5	"	4	"	"	"	"	"	"	"	"
Cambridge Crescent	11	19	"	"	1	"	"	12	6	6	13	3	7
Centre Row	7	15	1	"	"	"	"	4	"	"	5	1	2
Cotton Row	8	"	"	"	"	"	"	2	"	"	1	1	"
Camden Grove, Legge Lane	2	"	"	"	"	"	"	1	2	2	"	"	"
Crabtree Road	2	20	"	"	"	"	"	4	"	"	15	1	"
Cape Lane	2	5	1	"	"	"	"	"	"	"	"	"	"
Coxwell Road	1	32	"	"	"	"	"	8	"	"	22	"	"
Church Road, Lodge Road	2	5	"	"	"	"	"	2	3	3	1	1	1
Chapman Rd. (part of)	12	9	1	"	1	"	"	6	"	"	9	"	"
TOTAL...	"	6281	681	25	297	21	36	1208	406	669	1383	394	322
D													
Dale End	5 8	190	15	2	11	"	7	43	39	49	30	4	3
Dudley Street	7	62	6	"	"	"	"	15	3	4	19	"	"
Dean Street	7 9	55	10	"	4	"	"	16	6	8	6	12	"
Digbeth	9	207	15	1	27	"	6	43	34	47	13	27	3
Darwin Street	12	328	27	"	5	"	2	54	2	3	60	14	11
Duddeston Row	8	79	13	"	6	"	1	13	2	2	18	4	5
Duke Street	8 13	127	21	1	1	"	"	29	2	10	24	3	4
Dartmouth Street	13	274	27	2	20	"	"	35	4	5	24	25	5
Derby Street	12	66	1	"	"	1	"	3	"	"	6	"	1
Digby Street	5 13	40	7	"	3	1	"	12	1	2	11	1	4
Drury Lane	8	12	4	"	"	"	"	2	"	"	3	"	1
Doe Street	8	34	2	"	"	"	"	5	"	"	6	3	3
Dudley Road	2 1	168	2	1	13	1	1	23	3	103	24	7	8
Devon Street	13	84	"	"	"	"	"	5	"	"	5	24	"
Dymoke Street	12	182	12	"	1	"	"	38	"	"	38	23	3
Devonshire Street	2	55	1	"	"	"	"	3	"	"	2	13	"
Dollman Street	13	58	"	"	"	"	"	2	"	"	6	8	4
Duddeston Mill Road	13	135	6	"	5	"	1	13	"	"	31	3	"
Duchess Road	11	28	"	"	"	"	"	18	27	38	14	7	13
Dugdale Street	2	28	"	"	"	"	"	2	"	"	4	"	"
TOTAL...	"	2212	169	7	96	3	18	374	123	271	344	178	64

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E													
Edgbaston Street.....	7	152	8	"	5	"	"	16	19	25	12	"	4
Essex Street	10	107	18	"	2	"	"	13	"	"	15	"	1
Exeter Row	10	53	15	"	4	"	"	20	4	4	19	4	3
Ellis Street	10	61	14	"	1	"	"	11	"	"	13	2	6
Essington Street	16	103	2	"	3	"	"	15	1	3	19	2	4
Easy Row	10	21	4	"	7	1	"	19	12	12	14	"	4
Edwards Street	1	175	11	2	5	"	"	24	4	6	20	"	2
Edmund Street	6	82	31	"	9	2	1	27	15	21	24	1	2
Elvetham Road	11 10	23	"	"	3	"	"	11	6	9	19	2	5
Eyre Street	2	50	5	"	1	"	"	10	2	8	7	10	"
Engine Street	8	14	"	"	1	"	"	1	"	"	"	1	"
Edgbaston Road	11	4	"	"	2	"	"	4	4	7	3	1	1
Emily Street	12	84	8	"	3	"	1	"	"	"	"	"	"
Elkington Street	5	"	"	"	"	"	"	"	"	"	"	"	"
Enfield Road	11	"	"	1	"	"	"	"	"	"	"	"	"
Eastern Road	11	"	"	"	"	"	"	"	"	"	"	"	"
Ellen Street	2	18	"	"	"	"	"	8	"	"	15	"	"
Eden Place	6	"	"	1	"	"	"	1	1	11	"	"	"
TOTAL...	"	947	116	4	46	3	2	180	68	106	180	23	32
F													
Freeman St., Moor St.	8	19	10	"	"	"	"	7	1	1	10	1	2
Fazeley Street	8	79	8	"	1	"	"	14	1	6	15	6	2
Floodgate Street	9 8	132	27	"	4	"	"	17	2	2	13	14	3
Fox Strreet	8	91	2	1	1	"	"	13	1	2	17	2	2
Fordrough Street.....	10	129	20	"	6	"	"	19	2	6	20	4	9
Fleet Street	6	118	4	1	"	"	"	16	1	7	7	8	"
Frederick Road, Edgbaston	11	52	"	"	8	"	"	50	32	51	45	3	7
Fisher Street	5	32	10	"	"	"	"	"	"	"	"	"	"
Frederick St., Graham Street	2	44	11	2	4	"	"	33	18	36	20	6	8
Francis Road	11	68	"	1	3	"	"	38	61	82	28	36	31
Farm Street	3 4	489	36	"	8	"	1	16	5	7	51	49	21
Factory Lane	2	24	"	"	"	"	"	3	"	"	"	6	"
Forge Street..... ..	13	9	"	"	"	"	"	"	"	"	"	"	"
Foundry Lane	2	9	"	"	"	"	"	"	"	"	"	"	"
Freeth Street	1	128	10	"	5	"	"	20	4	4	21	17	6
Friston Street	1	250	1	"	11	"	"	39	"	"	49	"	4
Franklin Street	2	"	"	"	"	"	"	"	"	"	"	"	"
Fordrough Lane	12	"	"	"	"	"	"	"	"	"	"	"	"
Farm Lane	12	5	"	"	1	1	"	"	"	"	"	"	"
Frank Street, Highgate Street	12	35	"	"	"	"	"	"	"	"	"	"	"
Falconer Road	10	7	1	"	1	"	"	2	1	5	1	4	2
Frankfort Street	4	50	"	"	"	1	"	"	"	"	"	"	"
Ford Street	2	21	3	"	"	"	"	9	"	"	12	2	11
Francis Street	13	237	16	"	6	"	"	62	1	1	40	27	9
Freeman St., Nechells	13	83	"	"	"	"	"	7	"	"	15	15	"
TOTAL...	"	2111	159	5	59	2	1	365	130	210	364	190	117

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Great Queen Street...	7	9	"	"	"	"	"	8	6	8	"	"	"
Gooch Street	9 11	317	48	2	13	"	7	61	4	7	54	23	20
Gloucester Street.....	9	6	1	"	3	"	8	14	2	2	"	2	"
Gem Street	8	19	4	4	"	"	"	9	2	6	8	"	4
Glover Street	12	132	12	"	8	1	"	22	1	2	29	30	5
Great Barr Street ...	12	193	9	"	9	"	6	32	2	2	44	9	10
Gough Street	10	89	10	"	13	"	"	13	"	15	4	3	"
Gas Street.....	10	6	3	"	3	"	"	9	4	8	6	"	"
Granville Street	10	130	30	"	9	"	"	22	15	16	20	8	7
Grosvenor Street	8	72	7	"	1	"	"	3	"	"	5	5	"
Gopsall Street	13	60	2	"	"	"	"	6	"	"	8	1	1
Great Brook Street ...	13	196	21	1	20	1	1	31	2	11	39	20	9
Great Lister Street ...	13	404	28	"	18	3	7	93	6	6	114	25	15
Great Francis Street..	13	351	6	1	5	"	1	31	1	1	60	9	5
Great Charles Street..	6 3 1	86	72	1	15	"	1	72	32	63	36	39	22
Graham Street	2	89	13	3	2	"	"	12	6	9	9	10	5
Great Hampton Street	3 2	225	122	"	14	"	3	77	31	34	50	54	44
George St., St. Paul's.	6 2	39	21	"	3	"	"	15	12	25	5	7	5
Great Hampton Row.	3 4	266	42	"	14	"	4	38	8	9	29	25	30
Great King Street ...	3	310	27	1	9	"	2	73	2	2	55	40	24
Great Russell Street..	4	492	14	2	7	2	1	48	1	8	65	3	14
Guest Street.....	3	50	4	"	2	"	"	6	1	1	7	3	4
Gosta Green	5 13	26	2	"	6	"	"	4	"	"	4	"	"
George Rd., Edgbaston	11	37	"	"	15	"	2	36	29	29	26	12	11
Great Colmore Street.	10 11	464	19	1	11	"	"	53	"	"	70	18	12
Grant Street.....	10	98	3	"	1	"	"	3	"	"	4	"	1
George Street West...	2	136	2	"	2	"	"	15	1	3	22	5	1
Grosvenor St. West..	1	196	4	"	2	"	1	29	"	"	42	"	4
Glover's Lane	12	"	"	"	"	"	"	"	"	"	"	"	"
Gough Road.....	11 10	95	"	"	8	"	"	74	48	62	75	3	21
Gullet, Stafford Street	5	27	1	"	3	"	"	8	3	3	6	"	"
Gullet, Fordrough St.	10	"	"	"	"	"	"	"	"	"	"	"	"
Gullet, Bradford St...	9	"	"	"	"	"	"	"	"	"	1	"	2
Goode Street.....	2	42	2	"	1	"	"	"	"	"	"	"	"
Godwin Street	13	78	1	"	2	"	"	13	"	"	15	20	3
Great Tindal Street...	2	62	8	"	6	"	1	14	"	"	19	1	2
Guildford Street	4	62	3	"	"	"	"	7	"	"	9	1	"
Golden Hillock Road.	12	23	1	"	8	"	"	7	3	4	4	"	"
Garbett Street	1	210	6	"	1	11	"	23	"	"	34	"	3
Garrison Lane	12	190	19	2	8	2	"	33	"	"	42	18	2
Grindstone Road	11	8	"	"	"	"	"	"	"	"	"	"	"
George St., Nechells.	13	40	1	"	4	"	"	1	"	"	1	5	"
Glebe Street	1	40	1	"	1	"	"	8	"	"	8	"	"
Green St., Alcester St.	13	63	3	"	1	"	"	12	1	5	8	4	4
Geach Street	4	78	3	"	"	"	"	27	"	"	27	"	"
Gibb Street	12	24	9	"	5	"	"	5	1	1	2	8	2
Green St., Heath St..	2	38	2	"	"	"	"	11	"	"	13	9	"
Goodrick Street	13	28	2	"	"	"	"	10	3	3	17	4	"
Gee Street.....	4	33	1	"	"	"	"	3	"	"	2	2	"
Green St., Bloomsbury	13	10	"	"	"	"	"	1	"	"	2	4	"
Grantham Road	12	5	"	"	"	"	"	"	"	"	"	"	"
Greenway Street	12	102	"	"	1	"	"	16	"	"	63	"	"
Garrison Street	12	119	2	"	1	"	"	9	1	5	9	9	"
Green's Court	7	52	"	"	"	"	"	4	"	"	4	"	"
Glebe Passage	9	55	1	"	2	"	"	16	"	"	9	10	"
Grosvenor Row.....	8	"	"	"	"	"	"	"	"	"	"	"	"
Greave's Court, Moland Street	5	"	"	"	"	"	"	"	"	"	"	"	"
Gladstone Road	12	24	"	"	1	"	"	14	"	"	15	"	"
TOTAL...	"	6006	592	18	258	20	45	1151	228	350	1200	449	292

1. Ladywood. 2. All Saints. 3. Hampton. 4. St. George. 5. St. Mary. 6. St. Paul. 7. Market Hall. 8. St. Peter. 9. St. Martin. 10. St. Thomas. 11. Edgbaston. 12. Deritend. 13. Duddeston and Nechells

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H													
High Street, New St.	6 7	97	14	2	8	"	"	69	95	164	20	7	5
Henn's Walk	6	11	"	"	"	"	"	9	"	"	4	1	"
Hill Street	7	148	20	1	4	"	"	32	5	11	35	"	2
Hurst Street	6 10	165	12	2	3	1	1	30	10	14	33	"	5
High St., Deritend	12	255	27	1	18	"	4	34	15	20	15	41	7
High St., Bordesley	12	167	23	1	13	"	2	45	9	19	39	4	6
Heath Mill Lane	12	147	15	1	7	"	1	19	5	8	23	10	4
Hicks Square	8	8	"	"	"	"	"	"	"	"	"	"	"
Holloway Head	10	144	12	"	3	1	2	16	3	4	26	15	8
Holliday Street	10	180	8	"	4	"	"	15	"	"	18	12	7
Howe Street	13	144	6	"	2	"	"	19	2	2	31	1	2
Holt Street	13	148	18	"	13	"	"	24	1	2	25	14	11
Heneage Street	13	390	31	2	11	"	2	89	3	7	73	36	11
Henry Street	13	152	10	"	5	"	2	25	"	"	16	16	1
Horse Fair	10	52	24	"	4	"	1	19	2	5	23	2	5
Henrietta Street	3	58	13	"	3	"	"	6	"	"	7	7	7
Hall Street	2	61	17	"	"	"	1	28	4	5	23	2	8
Hockley Hill	3 2	71	30	1	15	1	5	51	22	22	38	19	42
Holland Street	6	43	9	"	1	"	"	8	"	"	6	5	4
Hanley Street	4	95	19	"	4	"	"	6	"	"	17	"	4
Harding St., Summer Lane	4	117	5	"	1	"	"	17	"	"	15	"	6
Hatchett Street	4	192	4	2	1	1	"	32	"	"	29	2	5
Hospital Street	4	321	32	1	3	1	2	20	1	1	29	14	15
Howard Street	3	57	35	"	"	"	"	17	4	4	19	1	6
Harford Street	3	48	17	"	1	"	"	3	5	14	3	5	6
Harborne Road	11	81	"	"	37	"	"	47	46	59	50	4	11
Hagley Road	11	200	3	4	97	1	"	194	171	269	133	67	51
Highfield Road	11	23	"	"	12	"	"	25	25	35	25	"	7
Hockley Street	3	70	22	1	2	"	"	16	"	"	14	2	5
Hall Hill Road	11	"	"	"	1	1	"	1	1	3	1	"	"
Helena Street	1	13	3	2	2	"	"	2	"	"	2	"	"
Henn Street	5	23	"	"	1	"	"	2	"	"	"	3	"
High Park Street	13	65	1	"	3	1	"	13	1	10	20	3	"
Hope Street, Gooch St.	9	331	12	2	4	"	1	51	"	"	62	18	14
Harding St., Soho Rd.	2	19	1	"	1	"	"	"	"	"	"	"	"
Holborn Hill	13	193	16	"	8	"	"	"	"	"	"	"	"
Highgate Place	12	33	"	"	1	"	"	"	"	"	"	"	"
Hob Moor Lane	12	5	"	"	4	"	"	"	"	"	"	"	"
Harrison's Road	11	10	"	"	1	"	"	"	"	"	"	"	"
Henley Street	12	93	5	"	4	1	"	"	"	"	"	"	"
Heath Street	2	286	9	2	12	"	"	88	3	3	66	70	12
Hope Street, Heath St.	2	2	1	"	"	"	"	4	1	1	2	"	"
Handsworth New Rd.	2	13	"	"	"	2	"	"	"	"	"	"	"
Hunter's Lane	3	7	"	"	1	1	"	2	"	"	6	"	"
Hockley Pool Road	2	32	"	1	"	"	"	7	1	1	33	"	16
Hingeston Street	2	174	7	"	2	"	"	25	"	"	35	12	1
Highgate Street	12	227	8	"	2	"	"	12	3	3	20	23	4
Hunter's Vale	3	6	"	"	"	"	"	"	"	"	"	"	"
Hylton Street	2	18	23	"	1	"	"	10	13	23	11	5	13
Hooper Street	1	25	"	"	"	"	"	"	"	"	"	"	"
Heath Street South	1	47	3	"	2	"	"	7	6	9	4	8	2
Hick Street	12	101	2	"	2	"	"	"	"	"	"	"	"
Hollier Street	12	63	"	"	1	"	"	12	"	"	14	"	"
Hubert Street	13	15	"	"	"	"	"	"	"	"	"	"	"
Herbert Road	13	156	1	"	1	"	"	34	2	2	113	"	2
Hyde Road	1	31	"	1	1	"	"	15	"	"	20	2	1
Holly Road	11	"	"	"	"	"	"	"	"	"	"	"	"

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H—*continued.*													
Heaton Street	2	13	"	"	"	"	"	2	"	"	4	"	3
Highgate Lane	12	73	1	"	2	"	"	8	"	"	24	10	3
TOTAL...	"	5709	519	27	329	12	24	1210	459	720	1226	447	325
I													
Inge Street	10 7	136	14	1	3	"	"	13	"	"	13	"	"
Ivy Lane	12	31	3	"	"	"	"	"	"	"	"	"	"
Islington Row	10 11	54	2	"	9	"	"	24	12	12	26	13	8
Islington	10 1	296	65	5	20	"	6	70	67	82	102	52	44
Icknield Street West.	1	307	7	5	19	1	2	100	13	14	121	44	8
Icknield Street East..	2	294	18	2	9	"	3	64	14	14	101	12	27
Irving Srreet	10	452	29	"	13	2	1	46	2	2	53	36	13
Ingleby Street	1	136	5	"	1	"	"	27	1	1	20	15	3
Icknield Square	1	175	3	"	3	11	1	24	1	2	27	13	5
Icknield Port Road...	1	457	11	"	2	1	11	71	4	13	87	44	7
Inkerman Street	13	104	1	"	"	"	"	18	"	"	22	20	4
TOTAL...	"	2442	158	13	79	15	24	457	114	140	572	249	119
J													
John Street	5	119	3	"	3	"	"	15	1	1	16	1	3
Jamaica Row	7 9	22	3	"	3	"	"	18	11	15	5	5	7
Jennens Row	8	33	17	"	"	"	"	8	"	"	10	"	4
Johnson Street.....	13	38	"	"	1	"	"	6	"	"	15	2	"
James Street.....	2	13	14	"	1	"	"	"	"	"	"	"	"
Johnstone Street	1	27	3	"	"	"	"	15	4	6	13	4	"
Jenkins Street	12	9	1	"	"	"	"	"	"	"	"	"	"
TOTAL...	"	261	41	"	8	"	"	62	16	22	59	12	14
K													
King Edward's Place.	1	35	9	"	1	"	"	1	"	"	"	"	"
King Alfred's Place...	1	17	10	1	2	"	"	13	5	11	15	"	2
King Edward's Road.	1	141	7	2	9	"	"	17	1	1	24	6	"
Kent Street	9	115	4	1	2	"	"	21	4	28	18	3	3
Kenyon Street	2	109	23	1	6	"	"	12	2	9	13	7	5
Key Hill	2	127	11	"	9	"	2	22	"	"	18	2	15
Kyrwick's Lane	12	146	1	"	7	"	"	24	"	"	53	43	1
Kingston Road..... ..	12	24	2	"	7	1	"	11	"	"	16	1	8
Kindal Street	12	"	"	"	"	"	"	"	"	"	"	"	"
King Street	12	25	"	"	"	"	"	4	"	"	7	5	"
Kent Street North ...	2	80	"	"	2	"	"	3	"	"	"	14	3
Kelynge Street.....	12	62	1	"	2	"	"	10	"	"	13	"	1
TOTAL...	"	881	68	5	47	1	2	138	12	49	177	81	38

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L													
Lionel Street	6 3	146	50	"	7	"	"	25	10	14	6	22	16
Loveday Street	4 5	128	74	"	6	1	1	31	5	11	28	5	10
Lench Street	5	115	34	"	1	"	"	9	"	"	9	9	"
Lancaster Street	5 4	232	46	"	"	"	1	47	5	7	30	14	13
Lower Tower Street...	4	295	22	1	11	1	2	31	"	"	32	3	9
Little Hampton St....	4 3	237	62	"	14	2	3	32	2	2	45	21	27
Ladywood Road	1 11	253	11	1	19	2	1	73	9	27	78	17	31
Latimer Street South	10	348	20	"	9	1	"	22	1	1	21	26	13
Lower Camden Street	2	144	4	"	3	"	"	11	"	"	32	10	3
Lee Crescent	11	66	"	"	1	"	"	24	4	4	47	"	2
Lower Hospital St....	4	77	3	"	"	"	"	12	5	5	18	2	4
Louisa Street	1	16	3	"	1	"	"	8	"	"	7	1	"
Lower Loveday St....	4	27	24	"	10	"	"	15	2	2	12	3	4
Little Cannon Street	8	17	1	"	"	"	"	5	5	8	3	"	"
Ledsam Street.....	1	220	3	"	7	1	1	32	1	1	35	11	7
Latimer Street...	10	40	1	1	"	"	"	3	"	"	4	3	4
Little Bow Street ...	10	24	1	"	"	"	"	"	"	"	"	3	1
Lee Bank Road	11	321	"	"	8	"	"	56	8	8	92	17	17
Lodge Road.....	2	239	12	1	25	1	2	26	17	47	1	104	16
Little Hill Street ...	10	33	5	"	"	"	"	4	"	"	5	1	2
Ladypool Lane	12	23	1	"	5	"	"	11	2	2	22	1	1
Ludgate Hill Passage	3	"	3	"	1	"	"	1	2	9	"	"	"
Lower Dartmouth St.	12	67	2	"	5	"	"	7	"	"	7	8	2
Little Shadwell St....	4	10	1	"	"	"	"	2	"	"	2	"	1
Lower Hurst St. East	9	24	2	"	"	"	"	3	"	"	3	"	"
Ladywell Passage ...	7	13	1	"	1	"	1	4	"	"	4	"	"
Longacre	13	162	10	2	6	"	"	"	"	"	"	"	"
Lower Temple Street	7	17	2	"	"	"	"	5	4	4	5	"	"
Lichfield Street	5 4	151	38	1	6	"	"	22	6	8	22	"	2
London 'Prentice St.	5	72	11	1	12	1	"	11	1	6	12	"	1
Lower Priory	5	21	4	"	2	"	"	6	3	4	7	3	"
Leek Street	8	17	11	"	1	"	"	9	"	"	7	"	1
Lease Lane	7	32	"	"	"	"	"	7	2	3	8	"	"
Lower Hurst Street...	9	146	5	"	5	"	"	16	2	2	20	6	7
Lower Essex Street...	9	195	21	"	5	"	"	34	2	2	29	9	10
Lower Pershore Street	9	52	7	"	3	"	"	11	"	"	7	8	5
Lady Well Walk	7	8	3	"	1	"	"	5	"	"	5	"	"
Lower Fazeley Street.	8	44	6	1	1	"	"	10	4	8	11	8	2
Lowe Street	12	23	1	"	"	"	"	6	1	2	7	"	"
Lombard Street	12	120	21	1	5	1	1	21	1	1	28	"	5
Lower Trinity Street.	12	82	11	"	7	"	"	13	3	3	12	12	6
Liverpool Street	12	42	5	"	3	"	"	10	4	9	2	9	"
Little Ann Street ..	8 9	52	8	1	1	"	"	1	"	"	"	9	1
Lawrence Street	8	100	5	2	"	"	"	10	1	5	7	7	1
Lawley Street	13	273	21	1	22	"	"	31	3	4	42	12	8
Lower Lawley Street.	12	20	4	"	2	"	"	6	1	1	7	"	"
Little Barr Street ...	12	49	2	"	2	"	"	7	"	"	9	1	2
Lower Windsor Street	13	57	5	"	3	"	"	9	"	"	12	2	"
Lister Street.....	13	51	8	"	2	"	"	16	3	4	14	3	"
Lord Street	13	69	5	1	2	"	1	4	"	"	4	1	"
Love Lane....	13	31	4	"	3	"	"	"	"	"	"	"	"
Lupin Street	13	165	4	1	4	"	"	40	2	2	23	30	5
Loxton Street	13	41	"	"	2	"	"	4	"	"	14	"	"
Legge Street..... ...	5 13	108	25	2	4	"	"	"	"	"	"	"	"
Livery Street	3 2	164	26	"	9	"	2	46	10	24	32	14	19
Ludgate Hill	3 6	68	19	"	8	1	"	20	4	7	3	18	11
Lee Mount	11	18	"	"	"	"	"	7	"	"	12	"	"
Lansdowne Street ...	2	19	1	"	1	"	"	1	"	"	1	16	"

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L—*continued.*													
Legge Lane	2	18	8	1	5	"	"	5	6	6	3	1	"
Leopold Street	12	136	21	2	9	1	"	25	2	6	24	8	"
Long Street	12	149	1	"	7	"	"	39	8	8	90	13	1
Lingard Street	13	33	"	"	"	"	"	8	"	"	7	"	"
Larches Street	12	112	3	"	3	3	1	22	"	"	57	15	1
Little King Street	3	74	6	"	3	1	"	9	"	"	3	17	2
Lower King Edward's Road	1	81	1	1	"	"	"	10	"	"	7	11	1
Little Francis Street	13	37	"	"	"	"	"	12	2	5	18	3	"
Lander Street	13	2	1	"	1	"	"	"	"	"	"	"	"
Lower Darwin Street	9 12	10	2	"	1	"	"	5	1	1	3	"	"
Little Broom Street	12	"	"	"	"	"	"	"	"	"	"	"	"
Lennox Street	4	62	"	"	"	"	"	13	"	"	9	"	"
Longmore Street	12	41	2	1	4	"	1	6	2	5	5	2	1
Lees Street (a new street)	2	11	1	"	"	"	"	"	"	"	"	"	"
TOTAL...	"	6350	725	23	289	17	18	1036	156	278	1151	519	975
M													
Minories	4 5	2	1	"	"	"	"	6	7	7	"	"	"
Moor Street	8	133	28	2	17	"	"	46	37	101	29	2	3
Masshouse Lane, Dale End	8	11	8	1	1	"	"	4	4	4	5	5	1
Mill Lane	9	19	4	"	3	"	1	7	1	2	"	5	3
Moat Lane	9	8	1	"	"	"	"	5	7	9	2	"	"
Moseley Road	12	279	11	"	37	1	2	84	30	50	103	15	17
Moseley Street	9 12	209	34	1	10	"	"	47	7	21	47	15	15
Meeting House Yard	12	16	1	"	2	"	"	1	"	"	"	4	"
Montpeller Street	12	20	1	"	2	"	"	8	1	2	5	4	1
Milk Street	9	140	15	"	2	"	"	12	"	"	8	13	"
Meriden Street	9	98	12	1	6	"	"	14	6	6	7	10	8
Marshall Street	10	55	2	"	"	"	"	3	"	"	3	4	1
Morville Street	1	193	5	1	5	"	"	44	4	7	43	10	5
Mill St., Sheepcote St.	1	64	6	"	1	"	"	5	"	"	6	1	3
Mill St., Dartmouth Street	13	17	6	"	2	"	"	1	"	"	1	2	"
Manchester Street	5	51	"	"	1	"	"	6	"	"	3	5	"
Mount St., Charlotte Street	6 2	117	11	"	1	"	"	11	5	10	8	11	12
Mary Ann Street	3	48	21	"	2	"	1	7	4	7	3	1	3
Mary St., Caroline St.	2	15	5	"	1	"	"	"	"	"	"	"	"
Moland Street	5	225	19	"	7	"	"	47	6	6	30	3	12
Mott Street	3	127	47	"	4	1	"	8	"	"	14	29	25
Mount St., Nechells	13	73	1	"	1	"	"	"	"	"	"	23	"
Monument Lane	11	80	1	"	19	"	"	41	34	42	44	20	12
Mount Street, High Street, Bordesley	12	36	1	"	"	"	"	1	"	"	"	4	"
Moat Row	9	14	3	"	3	"	"	"	1	1	4	1	2
Monmouth Street	3 8	5	"	"	"	"	"	3	5	26	3	"	2
Macdonald St., Summer Lane	4	80	10	"	3	"	"	"	"	"	"	"	"
Macdonald St., Sherlock Street	9 12	90	12	1	8	"	"	21	2	2	15	8	3
Montague Street	12 13	95	5	"	3	"	"	9	"	"	9	1	1
Main Street	12	60	"	"	2	"	"	14	"	"	37	"	1

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M—*continued.*													
Mole Street	12	72	3	"	"	"	"	"	"	"	"	"	"
Miles Street	12	128	3	"	7	"	"	7	"	"	13	4	"
Metchley Lane	11	22	"	"	4	"	"	"	"	"	"	"	"
Metchley Park Road	11	2	"	"	"	"	"	"	"	"	"	"	"
Masshouse Lane, Edgbaston	11	1	"	"	1	"	"	"	"	"	"	"	"
Moore's Row	8	12	1	"	"	"	"	"	"	"	"	3	2
Market Street	8	21	1	"	"	"	"	2	3	3	"	6	1
Moreton Street	2	45	2	"	1	"	"	6	"	"	10	1	"
Milton Street	4	48	6	"	3	"	"	10	"	"	6	6	3
Mount Pleasant	12	52	"	"	"	"	"	10	"	"	12	5	"
Miller Street	15 5	51	1	"	1	"	"	8	"	"	10	"	2
Moorsom Street	5	10	"	"	"	"	"	2	"	"	3	"	"
Marroway Street	1	"	"	"	"	"	"	"	"	"	"	"	"
Montague Road	11	3	"	"	"	"	"	1	2	2	2	"	"
Mount St., Lodge Rd.	2	11	1	"	1	"	1	"	"	"	"	"	"
Musgrave Road	2	41	3	"	"	"	"	5	"	"	16	9	"
Mary Street, Great Tindal Street	1	19	"	"	"	"	"	13	2	2	20	"	"
Marshall Street South	12	12	"	"	"	"	"	2	"	"	4	"	"
Mark Lane	7	16	1	"	"	"	"	"	"	"	"	"	"
Malvern Hill	13	13	"	"	"	"	"	"	"	"	"	"	"
Monor Road	11	6	"	"	"	"	"	3	6	6	6	"	"
Molliett Street	2	"	"	"	1	"	1	"	"	"	"	"	"
A New St. (off Watery Lane)	12	14	1	"	1	"	"	"	"	"	"	"	"
TOTAL	"	2979	294	7	163	2	6	524	174	316	531	230	138
N													
Newton Street	4 5	28	35	"	3	"	"	1	"	"	1	"	"
New Street	8 7	81	5	10	3	"	"	102	107	253	22	5	19
Needless Alley	8	1	"	"	2	"	"	5	5	9	2	"	"
New Inkleys	7	112	6	"	4	"	1	8	"	"	12	"	"
Navigation Street	7 10	147	13	"	1	"	1	17	3	3	21	4	7
New Meeting Street	8	14	4	"	"	"	"	6	4	7	4	"	"
New Bartholomew St.	8	39	14	"	1	"	"	5	3	14	6	1	1
New Canal Street	8	224	22	"	3	"	1	28	8	18	28	10	4
New Thomas Street	8	32	1	"	1	"	"	9	2	2	8	"	"
Nova Scotia Street	8	71	3	"	"	"	"	"	"	"	"	18	6
Norfolk Street	10	56	4	"	1	"	"	7	"	"	7	2	3
Nelson St., Nechells.	13	4	"	"	"	"	"	"	"	"	"	"	"
New Market Street	6	13	5	"	1	"	"	"	"	"	"	5	"
Newhall Street	6	82	32	3	17	"	"	47	38	78	16	20	10
Northwood Street	2 3	181	"	1	"	"	"	10	5	15	6	17	9
Northampton Street	2	57	43	"	2	"	"	28	11	17	21	7	18
Newtown Row	5 4	339	29	3	18	"	4	44	8	13	25	29	15
New Church Street	5	70	7	"	"	"	"	4	"	"	8	4	1
New Summer Street	5	216	31	"	1	"	"	8	"	"	12	"	2
New John St. West	3 4	689	58	2	8	1	2	94	2	13	97	45	43
Nelson Street South, Bristol Street	9	233	11	"	7	"	"	32	1	1	35	14	9
Norton Street	2	52	2	"	"	"	"	"	"	"	"	"	"
Newdegate Street	13	19	"	"	"	"	"	6	1	1	6	3	"
Northumberland St.	13	85	"	"	2	"	"	9	"	"	9	3	"

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N—*continued.*													
Newhall Hill	2	66	15	1	4	"	1	2	2	2	"	6	2
Nelson St., Sandpits.	1	61	3	"	2	1	"	11	"	"	16	"	"
Nursery Road	11	4	"	"	"	"	"	"	"	"	"	"	"
Norfolk Road	11	10	"	"	6	"	"	7	7	12	7	"	1
Nile Street	1	4	3	"	2	"	"	2	2	2	"	"	"
Norman Street.....	2	60	1	"	1	"	"	"	"	"	"	19	"
Nechells Place.....	13	98	"	"	4	"	1	6	"	"	9	3	"
New Spring Street ...	2	46	1	"	1	"	"	7	"	"	9	5	2
Nineveh Road	2	"	"	"	"	"	"	"	"	"	"	"	"
Northbrook Street ...	1	10	"	"	"	"	"	1	"	"	2	4	2
New England	12	"	"	"	"	"	"	"	"	"	"	"	"
New Bond Street.....	12	23	4	"	1	"	"	4	"	"	4	1	"
Nelson Street West, King Edward's Rd.	1	168	6	"	4	1	"	"	"	"	"	"	"
New Edmund Street	6 3	"	"	"	"	"	"	"	"	"	"	"	"
Nechells Park Road	13	266	2	2	9	"	3	38	1	10	94	31	1
New Bridge Street ...	10 11	19	"	"	1	"	"	8	2	2	7	2	"
Noel Road	11	26	"	1	3	"	"	14	13	13	21	1	12
New John Street.. ...	5 13	207	27	"	6	1	"	11	"	"	11	2	"
TOTAL..	"	3913	387	23	119	4	14	581	225	485	529	261	167
O													
Old Cross Street	8	83	4	1	3	"	"	17	"	"	13	1	3
Old Meeting Street...	7	20	3	2	"	"	"	7	3	4	7	"	"
Old Inkleys	7	29	"	"	"	"	"	4	"	"	3	"	"
Oxford Street	9	76	24	1	8	"	"	15	4	11	8	15	4
Oozells Street North.	1	42	5	1	3	"	"	7	2	2	8	1	6
Oozells Street	1	16	7	"	4	"	"	9	3	4	11	1	2
Oxygen Street	13	24	1	"	1	"	"	"	"	"	"	"	"
Ormond Street.....	4	90	11	"	3	"	"	23	"	"	14	6	4
Oliver Street	13	84	5	"	2	2	"	12	2	4	17	3	2
Old Square	5 4	12	1	2	6	"	"	3	3	4	"	"	"
Outlet Road.....	13	"	"	"	"	"	"	"	"	"	"	"	"
Osler Street	1	145	5	"	1	1	"	13	"	"	23	"	"
Oughton Place.....	12	65	1	"	3	"	"	"	"	"	"	"	"
Owen Street.....	10	82	"	"	"	"	"	12	1	1	12	7	3
Oliver Road	1	23	"	1	"	"	"	14	5	6	17	"	"
TOTAL...	"	791	67	8	34	3	"	136	23	36	133	34	24
P													
Park Street	8 9	160	10	"	9	"	"	27	1	1	23	4	"
Park Lane	9	33	2	"	1	1	"	6	"	"	7	1	"
Pickford Street	8	67	4	"	"	"	"	"	1	1	0	8	3
Princes Street	8 13	17	8	"	"	"	"	3	"	"	3	2	"
Powell Street	2	34	2	"	"	"	"	6	2	2	5	1	"
Penn St., Curzon St..	13	35	2	"	4	"	"	7	1	1	7	3	2
Prospect Row	13	35	9	"	4	"	"	16	1	1	10	3	6
Pitney Street	13	"	"	"	"	"	"	"	"	"	"	"	"
Pritchet Street.....	5 13	235	17	"	6	"	1	9	"	"	7	3	3
Pershore Road	11	142	"	"	22	1	"	79	54	60	89	46	12
Pope Street	2	162	21	"	2	"	"	"	"	"	"	"	"

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P—*continued.*													
Potter Street	5	55	1	"	1	"	"	10	2	8	7	2	3
Price Street	5 4	148	82	"	6	2	"	24	"	"	20	5	9
Princip Street	4	88	34	"	4	"	"	20	6	27	16	7	1
Plough & Harrow Rd.	11	15	"	1	2	"	"	22	12	20	9	7	4
Pigott Street	10	94	3	1	1	"	"	7	1	6	12	7	3
Paradise Street	6 7	26	4	6	6	1	1	30	25	47	21	"	13
Pershore Street	7	102	20	"	5	"	"	25	10	11	27	"	8
Phillips St., High St.	7	7	"	"	1	"	"	3	3	3	"	"	"
Pinfold Street	7	18	"	2	"	"	1	5	5	10	3	"	2
Parade	2 8 1	81	13	2	8	"	"	32	3	8	22	8	7
Priory Road	11	2	"	"	2	"	"	"	"	"	"	"	"
Pakenham Road	11	10	"	"	4	"	"	12	9	13	9	1	3
Phillips St., Summer Lane	4	71	2	"	1	"	"	15	"	"	18	"	"
Pitsford Street	2	13	6	1	"	"	"	3	4	12	3	7	7
Penn St., Heath Mill Lane	12	32	1	1	"	"	"	"	"	"	"	4	1
Palmer Street	12	105	4	1	3	"	"	12	"	"	13	14	4
Park Rd., Edgbaston	11	6	"	"	5	"	"	"	"	"	"	"	"
Portland Road	11 1	30	"	"	3	"	"	13	13	21	13	"	5
Park Road, Soho	2	419	13	1	11	"	2	36	2	2	49	25	19
Pritchett's Lane	11	2	"	"	"	"	"	"	"	"	"	"	"
Parker Street	11	54	1	"	2	2	"	5	"	"	21	1	"
Proctor Street	13	66	"	"	1	"	"	"	"	"	"	"	"
Peel Street	2	77	1	"	2	"	1	9	"	"	9	32	"
Poultry	7	"	"	"	"	"	"	"	"	"	"	"	"
Princes Row	8 13	18	1	"	"	"	"	3	"	"	5	"	"
Piddock Street	2	25	"	"	"	"	"	"	"	"	"	"	"
Prescott Strret	2	67	1	"	1	"	"	"	"	"	10	2	"
Passage, Potter Street to Aston Street	5	"	"	"	"	"	"	"	"	"	"	"	"
Passage, Watery Lane to Kingston Road	12	11	"	"	"	"	"	4	"	"	4	2	2
Passage, Allison St. to Park Street	9	"	"	"	"	"	"	"	"	"	"	"	"
Passage, Cambridge Cres. to Spring St.	11	"	"	"	"	"	"	"	"	"	"	"	"
Passage, Wheeley's Lane to Bath Row	10	16	"	"	"	"	"	"	"	"	"	"	"
Passage, Snow Hill to Slaney Street	4	"	"	"	"	"	"	"	"	"	"	"	"
Passage, Birchall St. to River Rea	12	"	"	"	"	"	"	"	"	"	"	"	"
Passage, Snow Hill to Summer Lane	4	"	"	"	"	"	"	"	"	"	"	"	"
Princess Road	11	15	"	"	"	"	"	8	4	4	10	"	2
Porchester Street	4	4	1	"	1	"	"	2	"	"	2	"	2
Paddington Street	4	18	"	"	"	"	"	2	"	"	3	"	"
Pebble Mill Road	11	"	"	"	"	"	"	"	"	"	"	"	"
Priestley Road	12	6	1	"	2	"	"	3	"	"	4	"	"
Passage, Park Street to Moor Street	8	"	"	"	"	"	"	"	"	"	"	"	"
Post Office Place	7	2	"	"	2	"	"	9	8	13	2	"	"
Parliament Street (a new street)	12	21	1	"	2	"	"	"	"	"	"	"	"
TOTAL	"	2644	265	16	125	7	6	474	167	271	463	195	120

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Q													
Queen Street	7	86	1	"	"	"	"	4	"	"	7	"	"
TOTAL.....		86	1	"	"	"	"	4	"	"	7	"	"
R													
Rope Walk	5	13	"	"	1	"	"	4	"	"	3	"	2
Rea Street.....	9	146	18	"	4	"	"	22	2	9	18	14	6
Ravenhurst Street ..	12	122	4	"	2	"	"	47	5	14	55	3	3
Ruston Street	1	100	4	"	3	"	"	16	"	"	17	"	6
Ruston Street North..		224	4	2	1	"	"	16	1	1	15	30	17
Ryland St., Islington	1	112	5	"	1	"	"	13	2	2	14	"	1
Ryland Street North.	1	133	7	"	4	"	1	29	2	8	30	6	9
Richard St., Vyse St.	2	18	14	"	"	"	"	9	6	7	15	1	14
Regent Street	2	4	2	"	"	"	"	2	1	2	1	"	2
Russell Street	5	45	16	"	1	"	"	5	3	5	4	7	2
Reservoir Road	11 1	45	"	"	5	"	"	8	7	7	12	5	"
Ryland Road	11 10	102	"	"	6	"	"	35	5	5	36	14	"
Regent Place	2	39	14	"	3	"	"	2	2	6	2	10	5
Regent Parade.....	2	12	14	"	1	"	"	7	3	5	6	6	7
Rocky Lane	13	81	2	1	3	"	"	"	"	"	"	"	"
Richard Street, Dartmouth Street ...	13	108	8	"	3	"	"	7	1	1	7	4	3
Railway Terrace, Vauxhall Road	13	67	2	"	4	"	"	"	"	"	"	"	"
Rowland Street	13	21	4	"	3	"	"	4	"	"	6	"	"
Rawlins Street.....	1	85	1	"	"	"	"	12	1	1	11	1	"
Rotton Park Road	11 1	9	"	"	1	"	"	9	1	5	5	3	3
Rea Street South.....	9	53	3	"	1	"	"	7	2	3	7	2	1
Railway Terrace, Nechells Park Rd	13	92	"	"	3	1	"	"	"	"	"	10	"
Regent Row	2	35	4	"	1	"	"	2	"	"	2	3	3
Rodway Street.....	4	21	2	"	1	"	"	6	"	"	5	2	"
Ratcliff Street	13	8	1	"	"	"	"	1	"	"	2	2	"
Richmond Hill Road	11	2	"	"	1	"	"	2	4	6	4	"	1
Rupert Street	13	124	5	"	2	"	"	5	"	"	4	14	"
Rotton Park Street ..	1	"	"	"	"	"	"	"	"	"	"	"	"
Radnor Street	2	57	"	"	"	"	"	"	"	"	"	"	"
Rann Street	1	29	"	"	"	"	"	7	"	"	11	2	2
Reservoir Retreat.....	11	18	"	"	"	"	"	9	6	6	16	"	2
River Street.....	8	22	7	"	"	"	"	9	7	9	5	2	"
Ratcliff Place	6	"	"	"	"	"	"	"	"	"	"	"	"
Ryland St., Darwin Street	12	59	6	"	"	"	"	4	"	"	2	8	1
Regent Park Road ...	12	36	"	"	1	"	"	"	"	"	"	"	"
TOTAL...	"	2042	147	3	56	1	1	299	61	102	317	149	97
S													
Steelhouse Lane	5 4	209	72	2	15	"	2	42	18	24	34	11	4
Stafford Street.....	5 8	105	1	"	2	"	1	22	"	"	19	"	3
Seymour Street	8	"	"	"	"	"	"	"	"	"	"	"	"
St. Martin's Lane ...	9	1	"	"	1	"	"	3	3	6	1	"	"
Spiceal Street	7 9	17	3	"	"	"	2	9	9	12	3	2	2
Smallbrook Street ...	7 10	139	9	1	16	"	4	34	31	45	30	"	6

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Name of Street or Road.	No. of Ward.	No. of Houses.	No. of Manufactories, Workshops, &c.	Number of Public Buildings.	No. of Stables.	No. of Cow-houses.	No. of Slaughter-houses.	No. of communications with the Sewers.	No. of Premises having W.C. draining into Sewers.	No. of Water-closets in each street.	No. of Ashpits draining into Sewers.	No. of Ashpits undrained.	No. of Ashpits covered.
S—*continued.*													
Summer Street, Navigation Street	"	37	7	"	1	"	"	8	"	"	8	"	"
Suffolk Street	10 7	255	23	2	11	"	2	60	12	21	55	18	32
Skinner Street	9	38	8	"	1	"	"	2	"	"	7	"	"
Skinner Lane	9	78	4	"	1	"	"	8	3	3	8	6	"
Smithfield Passage	7	33	4	"	1	"	"	6	"	"	6	"	"
Sherlock Street	9	464	34	"	16	"	2	76	6	6	86	26	26
Stone Yard, High St., Deritend	12	29	4	"	2	"	"	3	"	"	5	"	"
Stratford Place	12	9	"	2	2	"	"	11	3	4	6	2	2
Sandy Lane	12	136	7	"	3	"	"	21	"	"	26	"	"
Sheep Street	8	130	13	"	5	"	"	8	"	"	18	"	"
Severn Street	10	46	14	2	3	"	"	11	1	2	13	"	8
St. Martin's Street	10	130	11	2	4	"	"	18	1	4	23	7	2
Sheepcote Street	1	103	10	"	10	"	"	10	1	6	12	7	7
St. Mark's Street	1	34	1	"	"	"	"	"	"	"	"	"	"
Summer Hill Road	2	39	"	1	"	"	"	12	13	13	12	1	"
Summer Hill Terrace	1	28	11	"	5	"	"	12	4	4	5	5	"
St. James Street	13	32	1	"	3	"	"	"	"	"	"	"	"
Saltley Road	13	121	2	1	3	"	1	13	1	2	21	9	"
St. James Place	13	63	2	"	1	"	"	7	"	"	9	"	3
Snow Hill	4 3	145	30	1	15	"	3	36	48	84	24	21	15
St. Paul's Square	6 2 3	49	31	1	6	"	"	22	18	37	12	21	11
St. Luke's Street	9 11	135	6	2	5	"	"	20	2	11	26	6	5
Sun Street	10	130	11	"	5	"	"	11	"	"	18	3	5
St. George Street	4	176	13	"	2	"	"	6	"	"	13	3	8
Sun Street West	11 10	49	9	"	3	"	3	18	"	"	19	7	4
Snape Street	2	37	19	"	"	"	"	24	4	8	23	6	18
Slaney Street	4	82	15	"	7	"	"	11	6	8	8	13	3
Shadwell Street	4	46	16	"	7	"	"	30	12	15	7	2	3
Sand Street	4	23	9	"	2	"	"	5	"	"	5	4	4
Staniforth Street	5	181	37	1	4	"	"	21	3	5	10	25	4
Summer Lane	4	593	44	3	24	"	11	81	12	46	79	42	38
Smith Street, Great Hampton Row	3	223	46	"	3	"	"	8	"	"	8	8	7
Sir Harry's Road	11	13	"	"	10	"	"	14	11	17	7	3	6
St. Peter's Row	1	9	1	1	2	"	"	"	"	"	"	"	"
St. Martin's Row	1	10	"	"	"	"	"	"	"	"	"	4	"
St. Martin's Place	1	23	"	"	"	"	"	9	3	3	7	2	3
Sheepcote Lane	1	54	1	"	2	"	"	6	"	"	7	2	"
Summer Row	6 1	30	3	"	4	"	1	26	8	13	19	5	3
Spencer Street	2	93	46	"	2	"	"	23	12	23	15	12	21
Spring Hill	2 1	182	11	"	10	"	3	47	6	8	49	30	11
St. Mary's Row	5 4	17	28	"	1	"	"	6	4	5	7	12	7
Stratford Street	12	59	2	"	2	1	"	"	"	"	"	"	"
Stewart St., Spring Hill	1	163	8	"	7	1	1	25	"	"	19	18	2
Stour Street	1	112	1	"	"	"	"	13	1	3	10	6	1
Springfield St. West	1	146	2	"	1	"	"	"	"	"	"	"	"
Scotland Street	1	18	2	"	"	"	"	4	"	"	8	"	"
Smith St., Bloomsbury Street	13	29	1	"	"	"	"	4	"	"	7	1	2
Scott Street	13	9	"	"	"	"	"	2	1	1	2	3	"
Spooner Street	13	40	"	"	"	"	"	9	4	4	23	5	2
Swallow Street	7	48	"	"	1	"	"	10	2	2	11	"	"
St. Vincent Street	1	246	6	"	6	1	1	51	2	3	90	3	10
Sherborne Street	1	236	10	"	11	"	"	22	"	"	31	2	4
Stoke Street	10	98	6	"	3	"	"	14	"	"	17	"	4

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Name of Street or Road.	No. of Ward.	No. of Houses.	No. of Manufactories, Workshops, &c.	Number of Public Buildings.	No. of Stables.	No. of Cow-houses.	No. of Slaughter-houses.	No. of communications with the Sewers.	No. of Premises having W.C. draining into Sewers.	No. of Water-closets in each street.	No. of Ashpits draining into Sewers.	No. of Ashpits undrained.	No. of Ashpits covered.
S—*continued.*													
Spring Street	10 11	100	2	"	10	"	1	34	6	6	25	29	5
Speedwell Road	11	4	"	"	1	"	"	8	5	6	7	2	1
Salop Street	12	49	1	"	"	"	"	"	"	"	"	"	"
Saltley Street	12	40	4	"	"	"	1	4	"	"	4	5	2
Soho Road	2	78	8	"	3	"	"	"	"	"	"	"	"
Stone Yard, Bristol Road	11	"	"	"	"	"	"	3	"	"	"	3	1
Spring Vale	11 10	21	1	"	2	"	"	4	"	"	1	5	"
Shoe Lane	2	6	1	1	3	"	"	"	"	"	"	"	"
Sand Pits	1 2	56	1	"	2	"	"	4	"	"	4	1	"
Stratford Road	12	94	1	"	25	"	"	40	44	46	66	24	12
Stephenson Place	7	"	1	2	"	"	"	3	2	49	2	"	1
Scholefield Street	13	228	18	"	10	2	1	45	3	3	64	27	8
Sarah Street	12	1	"	1	"	"	"	"	"	"	"	"	"
St. Andrew's Street	12	52	2	"	1	"	"	6	"	"	10	11	3
Silver Street	5	16	"	"	1	"	"	"	"	"	"	"	"
Somerset Street	13	24	"	"	"	"	"	2	"	"	5	"	"
Stoney Lane	12	2	1	"	"	"	"	1	"	"	3	"	1
St. George's Terrace, Gt. Hampton Row	4	51	8	"	1	"	"	"	"	"	2	11	7
Sampson Road	12	18	"	1	1	"	"	7	2	2	9	"	"
Sutton Street	10	51	3	"	1	"	"	7	12	13	5	5	1
Shut Lane	8	6	3	"	1	"	"	"	"	"	"	"	"
Spark Street	12	30	"	"	1	"	"	6	"	"	10	5	2
Summer St., Sun Street West	11 10	127	2	1	"	"	"	42	1	3	57	22	5
Somerset Road	11	3	"	"	3	"	"	"	"	"	"	"	"
St. Stephen's Street	5	1	"	"	"	"	"	1	1	1	1	"	"
Smithfield Street	9	15	"	"	"	"	"	8	8	16	1	"	"
St. Mark Street West	2	58	4	"	"	"	"	"	"	"	"	"	"
Swan Passage	"	4	"	"	"	"	"	"	"	"	"	"	"
Speaking Stile Walk	10	19	2	"	"	"	"	3	1	3	4	1	1
St. Luke's Road	11 9	64	1	"	1	"	"	18	3	3	8	7	6
Saint Bartholomew's Churchyard	8	"	"	"	"	"	"	"	"	"	"	"	"
Scotland Passage	8	1	"	"	4	"	"	11	11	21	3	"	"
St. George's Terrace, Brearley St. West	3	"	"	"	"	"	"	"	"	"	"	"	"
St. George's Crescent	3	"	"	"	"	"	"	"	"	"	"	"	"
Spon Terrace, Ravenhurst Street	12	"	"	"	"	"	"	"	"	"	"	"	"
Stewart St., Nechells	13	2	"	"	"	"	"	"	"	"	"	"	"
Spring Hill Passage	1	7	"	"	"	"	"	2	"	"	2	"	"
Shakespeare Road	1	85	"	"	1	"	"	8	"	"	13	1	6
Summer Hill Street	1	85	6	"	2	"	"	20	"	"	25	"	2
Smithfield Yard	7	"	"	"	7	2	10	"	"	"	"	"	"
South Road	12	57	2	"	"	"	"	"	"	"	"	"	"
St. Philip's Churchyard	8	"	"	2	"	"	"	"	"	"	"	"	"
St. Clement's Road (a new street)	13	4	"	"	"	"	"	"	"	"	"	"	"
TOTAL	"	7539	427	30	322	7	50	1261	364	630	1324	522	360

														Doubleston and Seichelle

1. Ladywood. 3. Hampton. 5. St. Mary. 7. Market Hall. 9. St. Martin. 11. Edgbaston. 13. Duddeston
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V—*continued.*													
Vyse Street	2	94	35	"	8	"	"	30	8	11	43	21	18
Vicarage Road	11	17	"	"	10	"	"	17	16	23	17	"	6
Vittoria Street	2	68	40	"	1	"	"	25	21	59	15	20	7
Vaughton Street	12	167	3	"	3	"	"	22	"	"	23	24	"
Vauxhall Street	8	58	8	"	2	"	"	12	1	1	9	"	6
Vere Street	9	100	2	"	"	"	"	15	"	"	16	3	5
Vine Street	7	11	1	"	"	"	"	3	"	"	4	"	"
Villa Street	3	22	"	"	"	"	"	5	"	"	3	1	1
Victoria Grove	9	40	"	"	"	"	"	2	"	"	6	"	"
Villers Street	2	21	"	"	"	"	"	4	"	"	9	"	"
Varna Road	11	102	"	"	1	"	"	54	2	2	72	7	1
Vaughton St. South	12	43	7	"	3	"	1	15	1	1	19	"	5
TOTAL...	"	1020	111	"	33	"	1	227	52	103	268	104	59
W													
Waterloo Street	8	5	"	3	1	"	"	33	39	74	19	"	"
Warwick Street	12	148	14	1	4	"	"	24	1	1	6	1	4
Warner Street	12	48	2	"	1	"	"	1	"	"	"	11	1
Warwick House Passage	8	"	"	"	"	"	"	"	"	"	"	"	"
Worcester Street	7	76	3	"	1	"	"	29	34	37	7	"	"
Washington Street	10	55	5	"	1	"	"	11	"	"	13	3	4
Wharf St., Sufflolk Street	10	189	16	"	18	"	"	19	2	4	21	6	9
Wharf St., Lawley Street	13	27	3	"	1	"	"	6	"	"	6	1	"
Watery Lane	12	296	15	1	10	3	"	51	1	3	67	18	7
Willis Street	13	144	4	"	2	"	"	5	"	"	12	25	1
William St., Islington Row	10	279	12	"	13	"	"	37	"	"	39	10	6
Windmill Street	10	62	5	1	3	"	"	2	1	3	1	2	1
Wrentham Street	9	202	17	"	5	"	1	31	1	1	26	9	6
Wynn Street	10	192	10	"	5	3	"	"	"	"	"	"	"
Wheeley's Lane	10	85	5	"	3	"	"	8	2	4	10	6	1
Wheeley's Hill Road	11	5	"	"	2	2	1	"	"	"	"	"	"
Woodcock Street	13	136	31	1	7	1	"	35	4	17	41	6	7
Water Street	6 3	92	1	"	1	"	"	13	2	5	10	7	8
Wellington Road	11	76	"	"	29	"	"	52	43	56	50	19	22
Warstone Lane	2	200	44	"	5	"	"	57	15	22	42	17	30
Whittall Street	5 4	48	62	1	3	"	"	18	16	25	9	15	8
Westbourne Road	11	11	8	"	"	"	"	7	9	22	8	1	4
William Street North	4	68	15	"	1	"	"	5	"	"	7	4	6
Wheeler Street	3 4	304	3	2	7	"	"	52	8	8	50	32	18
Weaman Row	5	10	18	"	2	"	1	6	2	4	2	7	6
Weaman Street	4	208	50	"	2	"	"	24	15	25	19	15	15
Well Street	3	275	15	"	7	"	"	63	4	4	52	31	16
Ward Street	4	78	12	"	2	"	"	"	"	"	"	"	"
Wood St., Bath Row.	10	30	11	2	4	"	"	8	"	"	10	3	3
Weston Street	13	45	2	"	1	"	"	3	"	"	9	1	3
Windsor Street	13	31	3	"	"	"	"	5	"	"	4	"	1
Witton Street	12	57	2	"	"	1	"	6	"	"	8	9	"
Winson Green Road	2	103	1	1	4	"	"	18	1	541	16	39	3
Well Lane, Masshouse Lane, Edgbaston	11	5	"	"	1	"	"	"	"	"	"	"	"

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W—*continued.*													
William Street, Lower Trinity Street ...	12	13	2	"	"	"	"	"	"	"	"	"	"
Wrottesley Street.....	7	13	3	1	1	"	"	8	8	12	4	"	"
Well Lane, Allison St.	9	10	3	"	1	"	"	"	"	"	"	"	"
Whitmore Lane	12	18	"	"	7	"	"	6	5	6	7	5	"
Winson Street.....	2	82	1	"	1	"	"	13	1	1	19	35	11
Wellington St., Winson Green Road	2	34	"	"	1	"	"	4	1	4	7	6	"
Wheeley's Road	11	49	"	"	5	"	"	33	35	54	54	"	22
Wharf Street, Park Road	2	65	3	"	4	"	"	"	"	"	"	"	"
William Henry Street	13	22	"	"	"	"	"	5	"	"	4	14	"
Wellington Place, Nechells	13	"	"	"	"	"	"	"	"	"	"	"	"
White Lion Passage, Aston Street.....	8	2	"	"	1	"	"	"	"	"	"	"	"
Wellington St., Farm Street	3	16	2	"	1	"	"	3	"	"	2	1	"
Wiggin Street	1	3	3	"	1	"	"	2	2	2	2	1	"
Wood Street, St. Vincent Street	1	1	"	"	"	"	"	1	1	3	1	"	"
Wyndham Road	11	13	"	"	"	"	"	7	2	2	9	3	2
William Edward St.	12	104	9	"	3	"	"	17	1	1	19	21	4
Wellington Passage...	8	"	"	"	"	"	"	"	"	"	"	"	"
Westley Street.....	12	3	"	"	"	"	"	3	"	"	3	"	"
Warstone Parade West	2	3	"	"	"	"	"	3	1	1	3	"	2
Warstone Parade East	2	6	"	"	"	"	"	6	4	9	3	3	1
Waterworks Road ...	11	42	"	"	"	"	"	6	"	"	7	1	2
Westfield Road	11	3	"	"	2	"	"	5	4	9	5	"	1
Wilton Street	3	46	1	"	"	"	"	11	"	"	9	1	"
Whitmore Street.....	2	32	"	"	"	"	"	14	1	1	14	5	"
Western Road	2	1	1	"	"	"	"	1	1	2	"	6	"
Wellington Street, Icknield Square	1	30	1	"	"	"	"	"	"	"	"	"	"
Wharf Street, Moseley Road	12	15	2	"	6	"	"	"	"	"	"	"	"
William St., Nechells	13	4	"	"	"	"	"	"	"	"	"	"	"
TOTAL...	"	4219	420	14	180	10	3	777	267	963	736	400	235
Y													
York Street	5	28	3	"	"	"	"	6	3	8	5	1	2
Yew Tree Road	11	18	"	"	1	"	"	11	9	9	18	"	4
York Road	11	19	"	"	"	"	"	9	12	14	11	"	2
York Passage	8	"	"	"	"	"	"	1	3	4	1	"	"
TOTAL...	"	65	3	"	1	"	"	27	27	35	35	1	8

SUMMARY.

SHOWING STREETS SEWERED AND DRAINING INTO THE RIVER TAME AT SALTLEY.

	No. of Houses.	No. of Manufactories, Workshops, &c.	Number of Public Buildings.	No. of Stables.	No. of Cow-houses.	No. of Slaughter-houses.	No. of communications with the Sewers.	No. of Premises having W.C. drain into Sewers.	No. of Water-closets in each street.	No. of Ashpits draining into Sewers.	No. of Ashpits undrained.	No. of Ashpits covered.
A	2447	232	9	155	8	20	450	148	270	495	227	138
B	8364	966	33	413	17	15	1512	462	725	1525	623	466
C	6281	681	25	297	21	36	1208	406	669	1383	394	322
D	2212	169	7	96	3	18	374	123	271	344	178	64
E	947	116	4	46	3	2	180	68	106	180	23	32
F	2111	159	5	59	2	1	365	130	210	364	190	117
G	6006	592	18	258	20	45	1151	228	350	1200	449	292
H	5709	519	27	329	12	24	1210	459	720	1226	447	325
I	2442	158	13	79	15	24	457	114	140	572	249	119
J	261	41	"	8	"	"	62	16	22	59	12	14
K	881	68	5	47	1	2	138	12	49	177	81	38
L	6350	725	23	289	17	18	1036	156	278	1151	519	975
M	2979	294	7	163	2	6	524	174	316	531	230	138
N	3913	387	23	119	4	14	581	225	485	529	261	167
O	791	67	8	34	3	"	136	23	36	133	34	24
P	2644	265	16	125	7	6	474	167	271	463	195	120
Q	86	1	"	"	"	"	4	"	"	7	"	"
R	2042	147	3	56	1	1	299	61	102	317	149	97
S	7539	427	30	322	7	50	1261	364	630	1324	522	360
T	1612	134	7	63	1	2	298	77	142	316	116	62
U	1166	153	5	31	"	4	219	70	112	199	65	61
V	1020	111	"	33	"	1	227	52	103	268	104	59
W	4219	420	14	180	10	3	777	267	963	736	400	235
Y	65	3	"	1	"	"	27	27	35	35	1	8
TOTAL	72087	6835	282	3203	154	292	12970	3829	7005	13534	5469	4233

N.B.—With reference to the Stables and Cow-houses, it is estimated that not more than two-thirds thereof are drained direct into the Sewers.

Borough Surveyor's Office, August, 1871.

STREETS SEWERED AND DRAINING INTO RIVER COLE.

Name of Street or Road.	No. of Houses.	No. of Manufactories, Workshops, &c.	Number of Public Buildings.	No. of Stables.	No. of Cow-houses.	No. of Slaughter-houses.	No. of communications with the Sewers.	No. of Premises having W.C. draining into Sewers.	No. of Water-closets in each street.	No. of Ashpits draining into Sewers.	No. of Ashpits undrained.	No. of Ashpits covered.
Albert Street	47	3	"	5	"	"	20	1	1	32	"	3
Baker Street.....	78	8	"	1	"	"	19	"	"	32	12	"
Coventry Road (part of).....	144	8	"	33	2	2	54	38	43	67	22	16
Chapman Road (part of).....	22	"	"	"	"	"	11	"	"	22	"	"
Dawson Street	15	"	"	1	"	"	4	"	"	10	1	8
Golden Hillock Road (part of)	23	1	"	8	2	"	7	"	"	14	"	"
Green Lane (part of).....	186	"	1	33	7	"	49	5	5	60	18	4
Grange Road	78	1	"	7	"	"	25	2	2	40	6	3
Hawkes Street	81	10	"	1	"	"	23	"	"	35	"	3
Little Green Lane (part of)	95	5	1	4	"	"	11	"	"	19	"	1
Lloyd Street.....	4	"	"	"	"	"	1	"	"	3	"	"
Muntz Street	113	2	1	9	1	1	42	"	"	54	12	3
North Warwick Street	1	"	"	"	1	"	1	"	"	1	"	"
Talfourd Street	75	3	"	"	"	"	4	"	"	13	"	"
Victoria Street.....	51	"	"	2	"	"	13	2	2	16	13	"
Wright Street	90	3	"	3	"	"	18	1	1	30	2	4
Wordsworth Road	33	"	"	4	"	"	8	6	6	10	4	"
TOTAL.....	1136	44	3	111	13	3	310	55	60	458	90	45

All the above Streets are in Deritend and Bordesley Ward.

APPENDIX II.

Circular, addressed by the Committee to the Honorary Physicians and Surgeons, and Parochial Medical Officers of the Borough, and the replies received thereto.

Report of the Borough Surveyor on the health of Nightmen employed by the Corporation.

APPENDIX II.

SEWAGE INQUIRY COMMITTEE.

Town Clerk's Office,
Birmingham, July 18th, 1871.

Mr. Mathews

Circular to the Honorary Physicians and Surgeons, and Parochial Medical Officers of the Borough.

Sir,—I am instructed by this Committee, respectfully to invite your opinion as to any effect on the public health which you may have observed, in your medical experience, to be caused by gases exhaling from the sewers, and at the same time to solicit suggestions for the remedy of any evil arising therefrom.

The special questions on which the Committee are anxious to obtain information are as follow:—

1. Do the character, and the constituents of gases, if any, escaping from the sewers indicate that they result to a great extent from the connection of water-closets, privies, ashpits, and middens with the sewers, and the consequent introduction therein of animal excreta?

2. Have you observed in the course of your practice, that the water used for drinking or domestic purposes, obtained from wells situated in the vicinity of ashpits and middens, is contaminated to any serious extent by drainage into the wells from such ashpits and middens?

3. The effect on public health of gases, if any, escaping from the sewers into the interior of dwelling houses, through water-closets or drains.

4. The effect on public health of the system of open privies, ashpits, and middens so extensively used in the crowded courts and densely-populated districts of Birmingham; whether such ashpits and middens are drained into the sewers or otherwise.

5. The effect on public health of the use of water, for drinking or domestic purposes, contaminated as above described.

6. Does your medical experience lead you to conclude that small-pox, scarlet, typhus, or other fevers, cholera, or any other diseases, epidemic or otherwise, are directly traceable to any of the above-mentioned causes?

7. Can you suggest any remedy for the injurious effect, if any, on the public health, which in your opinion is thus traceable?

The Committee will be greatly obliged if you will have the kindness to give them, at your earliest convenience, as much information as possible on all or any of these points.

I am, Sir,
Your obedient servant,
G S. Mathews, Secretary.

Appendix II.

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Sewage Inquiry Committee.
Newhall Street, August 23rd, 1871.

Dr. J. Russell

Dr. Russell presents the following replies to the questions he has received from Mr. Mathews in behalf of this Committee :—

1. I possess no analysis of sewer gases ; without such analysis any reply which I could afford would deal with probabilities only.

2. I possess only one chemical analysis of well water under the circumstances specified. In this case the well, though situated 16 yards from the privy, was impregnated with organic matter of animal origin. Enteric fever affected five members of the household. Ample testimony, however, to the great liability of wells, particularly of shallow wells, to undergo contamination by sewage matter, and to the general prevalence of such contamination, is afforded by the Report of the Medical Officer of the Privy Council. Evidence of similar character, relating to the wells of this town, has been collected by Dr. Hill ; evidence relating to the wells of the city of London was adduced by the Registrar-General in his Report on the Cholera Epidemic of 1866, published as a supplement to his twenty-ninth Annual Report.

In the tenth Report of the Medical Officer of the Privy Council will be seen a series of very striking investigations into the origin of three different epidemics of enteric fever, each of which was traced to the contamination of well and spring water with sewage matters.

3, 4, 5. In replying to these questions I must refer to various sanitary reports issued annually, and to well-known treatises on the pathology of the various epidemic diseases. I may particularise Dr. Murchison's inquiry into the cause of the various forms of fever ; Dr. Snow's investigations as to the manner in which epidemic cholera has been introduced and propagated ; and to the report on the cholera epidemic of 1866, by the Registrar-General, already mentioned.

I may also refer specially to the report presented to the Privy Council by Dr. Greenhow on the origin of epidemic diarrhœa in Birmingham, and in certain other towns, 1859.

These several authorities concur in referring to organic matter in a state of decomposition as being a most important agent in originating epidemic disease ; the evidence they adduce further leads to the conclusion that animal as distinct from vegetable matter has the chief share in influencing the prevalence of this class of disease.

Animal refuse of all kinds must be included in this category ; but animal, and chiefly human, excrement constitutes the principal portion of the material to which the evils in question are to be referred. This arises from the obvious circumstance that human excrement exists in large quantity, that it is generally diffused, that it is continually renewed, and that it is confined in receptacles or in sewers ; possibly, also, because the gaseous matters which result from decomposing human excrement may possess certain special properties as originators of disease.

Air and water are the principal vehicles by which the poisonous products now mentioned are conveyed to the human body;—the air, as poisoned by the open middens, privies, and cesspools, referred to in Question 4 ; or as contaminated within dwelling houses by badly-trapped drains or ill-constructed closets, or by accidental communications with sewers, as noticed in Question 3 ;—the water as contaminated by leakage through the soil, or, as frequently happens, by more direct communication between the receptacles in which it is contained and sewers, middens, &c., (*vide* Question 5).

What is the relative share of condemnation which properly belongs to each of these vehicles, water and air, has not been accurately distinguished. The answer would involve the quantity of poison contained, and the capacity for holding it ; it would also concern the manner in which the vehicle obtains its supply of poison. Moreover, an important element in the inquiry would be the nature of certain epidemic poisons of a specific character, which are found at particular seasons associated with the product of sewer decomposition ; a subject which falls under my reply to the next question.

Of the two vehicles mentioned, water would appear to be the more dangerous as a carrier of morbid poisons. Chemical analysis has demonstrated the great extent to which it is contaminated by sewage matters. The degree of facility with which, when poisoned, it may again be rendered wholesome by percolating through porous rock or by flowing in an open stream in contact with fresh and growing plants, is still undecided. Ample experience also testifies that, even when highly impure, it may be drunk without its noxious quality being suspected. The celebrated Broad Street pump was found to afford water described as little better than liquid sewage ; yet it was proved to have been the originator of a localised epidemic of malignant cholera in the district of Golden Square, in consequence of having been employed by the inhabitants as an article of diet.

It is probable, moreover, that the facilities for absorption are greater in the case of fluids remaining for a considerable period in the stomach and bowels than in that of

air passing rapidly through the lungs. But although what I have just written be true of water, there is ample proof that air must remain chargeable with a very important share in conveying the gaseous producers of disease.

Hence, under all the circumstances enumerated in Questions 3, 4, and 5, the presence of the results of the decomposition of animal excrement will be highly prejudicial to public health, by causing or favouring the production of epidemic disease.

6. This question opens the inquiry as to what are the diseases in which a specific poison is necessary, in order to bring them into existence, poisoned air or water playing only a subordinate part, by depressing health, and so rendering the body more liable to be affected by poison, and by affording nutriment to the specific poison; and what are the diseases of which the gaseous and other products at present under consideration are the sole and sufficient originators? It is not, however, necessary for the present purpose to distinguish between these two classes of diseases, since it is fully proved that even in the case of the specific poisons, such as the poison of small-pox, typhus fever, measles, &c., the presence of organic decomposition going on in the neighbourhood of human habitations materially favours the development of the diseases to which such poisons give rise. It may even be doubted whether any of the specific poisons—say of typhus or cholera—would fructify in a pure atmosphere or in pure water.

Hence I reply to the question that experience, far more extensive than my own, has demonstrated that the agencies specially referred to in the several questions are always the most active, if not the sole, causes of epidemic disease.

I must further observe that I have hitherto regarded the products of excremental decomposition in their relation to epidemic disease. There can be little or no doubt that the same products exert a further and most powerful influence in depressing the ordinary state of health among the inhabitants of districts where these are thrown off.

The late Dr. Barker, of Bedford, confined small animals in closed chambers through which a stream of sewer gases was passed. He produced in these animals a state of feverish irritation, which may be taken as the index of a series of minor disorders producible in the human body by similar means, leading to permanent degradation of health, and deeply influencing the nutritive processes.

7. My reply to this question would involve a knowledge of the present state of the town as regards its sanitary arrangements, which I do not possess; I, therefore, abstain from making an answer which could only deal with generalities. But as I have long entertained a strong opinion in favour of the town possessing a well-qualified Medical Officer of Health, I do not feel justified in withholding the expression of this opinion on the present occasion.

Sanitary medicine has now attained the position of a science, and can be practiced only by one instructed in its principles.

Much greater precision in our knowledge of the conditions necessary for preserving public health has been attained within the last ten years than was formerly possessed, and means have been pointed out for preventing the springing up of disease in a community, and for checking its extension, if unfortunately it may have arisen, which are entirely beyond the power of an uneducated sanitary officer, such as the town at present possesses. It is now well known that other diseases than those merely of an epidemic or contagious character are greatly influenced by local conditions which are under the direct control of the authorities. Consumption is a striking illustration of the truth of this assertion; and, therefore, the duties of a public Officer of Health extend far beyond those which relate to the removing of nuisances, the securing of proper ventilation in courts and lodging houses, &c.

It is true that from various circumstances proper to the town, the conformation of the surface, the nature of the rock on which it is built, the proportion between acreage and population, and the nature of the occupation of its inhabitants, the death rate of Birmingham contrasts favourably with that of many other towns. But still the death rate is improperly high as compared with the advantages which the town enjoys, and much preventible disease exists within it. Enteric fever is endemic here; the death rate from diarrhœa is high; contagious disease spreads, from the absence of simple and well-understood precautions; disease is engendered in various manufacturing processes which might be prevented by means within reach. In these and in many other particulars the field of operation for a Medical Officer of Health is quite as wide in Birmingham as in any other town.

I will only add that should, at any time, an epidemic of cholera attack the town, it would be deeply impressed upon us how greatly an instructed officer, well acquainted with the condition of the town, is needed for putting into operation the required measures with anything like promptitude and efficiency.

JAS. RUSSELL.

Appendix II.

Dr. Anthony.

To the Sewage Inquiry Committee.

Gentlemen,—Appended are answers to the questions with which you have honoured me.

I have studiously made these answers as brief as seemed consistent with clearness, and while keeping carefully to the subject matter of each query, I have preferred to give you practical conclusions derived from my own experience, rather than theories based upon the statistics of others.

I venture a sincere hope that my suggestions may aid, in ever so small a degree, in solving a most important problem in *hygiène*.

I have the honour to be, Gentlemen,

Very obediently yours,

JOHN ANTHONY, M.D., Cantab., F.R.M.S., &c.,

Member of the Royal College of Physicians of London, and Stipendiary Consulting Physician to the Birmingham General Dispensary.

Birmingham, August 1, 1871.

1. My experience lies more with gases escaping from the sewers in houses than with the continuation of such sewers along the streets. The odour and general character of these gases are indicative of their origin from human excreta, with the occasional presence of decaying animal or vegetable matter. Very few houses where the water-closet system is in operation are free from more or less taint in the atmosphere, due to escape of gases from drains, which too frequently are allowed to be stagnant, or, from want of a proper water supply, to be choked by matter in a state of fermentation.

2. I believe that serious contamination of the water, under conditions described in the question, is the rule and not the exception. In the modern small buildings, for economy and space, it is usual to place the privy or cesspool and the pump within a few feet of each other, and as the cesspool or privy is only emptied at rare intervals, a filtration into the well is a constant occurrence. Sometimes the water will smell so abominably as to make the pollution evident at once. In other cases the water looks bright and clear, but analysis makes it patent that the fluid is loaded with organic matter. Where the existence of special maladies has made it advisable to investigate the drains, I have found that for "convenience" they have been constructed to crop over the mouth of the well, which received its contamination from the oozing from the drain. From the wells of small holdings, where the soil is porous, it has been most rare for me to find water free from organic matter.

3. I do not think gas given off from fresh excreta, or where it can mix freely with the atmosphere, to be injurious to health, but this is seldom the case where the gas comes up from the drains in connection with water closets; the pent up matter seems to evolve compound gases, which are not only highly offensive, but which are really most prejudicial to human life. They seem to act as blood poisons, and when inhaled at all continuously, bring on maladies of a typhoid character, which are amenable to no remedies except a thorough change to a pure atmosphere. I have repeatedly seen such diseases, and, having traced their origin to the emanations from a fœtid drain the suppression of the cause has always had the happiest effects.

4. I do not look upon open privies, ashpits, and middens as injurious to health, providing their contents are not in too confined a space, so that the gases have a difficulty in escaping into the atmosphere. All ferments seem to be poisonous in the ratio in which their gases are prevented from being diluted. The heterogeneous contents of middens and privies must and do ferment, particularly in warm weather, and so are obnoxious to health in crowded localities; though in the densely-populated districts of Birmingham, the dirty habits of the people, and the utter absence of anything like fresh and pure air, would render it extremely difficult to estimate the amount of disease arising from any one specific cause. Still, I am of opinion that a foul midden or privy in a "crowded court," has an injurious effect on the health of the inhabitants.

5. The effect on the public health from habitually drinking contaminated water—that is, water into which matter from the cesspools has oozed—is similar to that produced by the respiration of the contaminated air; only in the former case, the symptoms are more marked, and, coming on more rapidly, the virulence of the poisoning is more decided. If the incipient signs are neglected, or are misunderstood, then some forms of low fever, such as typhus, or scarlatina, are sure to set in, and in certain neighbourhoods, these maladies are constantly present, simply because the causes which give rise to them are habitually ignored.

Nature will frequently try to get rid of this poisonous matter from the system, by setting up diarrhœa, which often becomes chronic from the persistence in the

Dr. Anthony.

original cause, and, when spasm supervenes, as it commonly does, the case is dignified with the name of cholera.

6. Experience has shewn me that, with the exception of small-pox, all the other maladies named in the question can be, and constantly are, occasioned by the before-mentioned vitiation of the air we breathe and the water we drink. I have not unfrequently discovered the existence of a foul but unsuspected drain, from the occurrence of isolated cases of fever in a district where there had been no chance of contagion. The disease was manifestly due to the local poison, and only disappeared from the locality when the presumed cause was no longer allowed to exist.

7. Without going into detail, I venture to suggest, that as there is every reason to believe that disease is caused from the contamination of water, and that a common cause of such contamination is the habitual close proximity of well and cesspool; then, that either the cesspool should not be allowed to exist in its present form, or that some stringent enactment should define the minimum distance for a privy or cesspool from a well of water used for drinking and for household purposes.

With regard to the vexed question of the deportation of human excreta, &c., I should be entirely in favour of the use of "earth-closets," if I could bring myself to believe that the genius and habits of the more numerous class lay in the direction of order and system—such a system as would be required for closing up, and transporting at regular intervals, so large an amount of material of a more or less offensive character. A few "breaks-down" would call forth a storm of opprobrium on a system which I cannot help feeling to be theoretically right; a system only requiring some small amount of trouble from the individual—which he would not take—and great precision on the part of the soil-removing executive, which experience has taught us would soon cease to be employed. Rejecting with disgust any recurrence to the heretofore filthy custom of draining excreta from large towns into rivers and brooks, I see nothing remaining but either draining the sewage on to "hungry land," or, what I think both more feasible and more desirable, viz., the *drying the more solid parts of the sewage in closed chambers or boilers*, charged and emptied in succession, the steam and gases from which would be made to *pass through a glowing fire of coke, constantly kept up*, at the base of a shaft common to a circle of boilers. Fire is so thorough a purifier that it is difficult to see what nuisance could be produced in a process of drying the material for agricultural use, when it is taken into consideration that the *supernatant fluid could be siphoned off from each boiler after a few hours' subsidence*, the thick portion of the sewage only being dried, and the gaseous matter being consumed by a fire which, from its nature, gives off no smoke.

I put forth this suggestion with all diffidence, though it is one which has not been set down without considerable thought being given to its advantages and disadvantages.

120, Bath Row, Birmingham, July 31st, 1871.

Mr. J. Darwen

SIR,—In answer to your letter requesting information concerning the injurious effects of the exhalation of gases from the sewers, and their remedy, I beg to state that—

1. I am of opinion that the noxious gases escaping from the sewers are caused by their connection with the water-closets, privies, and ashpits. In this I am supported by the fact that in many houses it was unnecessary to employ stink-traps to the drains prior to the common practice of emptying the contents of water-closets, &c., into the sewers. I attribute the alteration in the quality of the gases exhaled almost entirely to the decomposition of animal matter derived from the water-closets.

2. I have frequently observed that water obtained from wells in the vicinity of ashpits becomes unfitted for domestic purposes, owing to being impregnated with compounds of sulphuretted hydrogen and nitrogenous matter. The pollution of wells throughout the town is more frequent than is generally supposed.

3. The effect of the escape of sewage gases into the interior of houses, according to my experience, depresses the vital powers, and renders the animal economy more susceptible to contract diseases of a zymotic character.

4. The system of open ashpits and privies in the crowded courts of the town has undoubtedly a similar tendency.

5. The effect of drinking water contaminated with the contents of the ashpits, &c., causes disorders in the stomach and bowels, as nausea, vomiting, diarrhœa, &c.

6. My experience leads me to the conclusion that although such diseases as small-pox, scarlet fever, typhus, typhoid, &c., owe their origin to specific causes, yet their increase among the public, especially among the lower classes, is to be attributed

Appendix II. — Mr. J. Darwen

to the fact of the residences of the victims being in close proximity with the open midden, to the use of water containing injurious compounds derived from the ashpits, and to the inhalation of gases derived from the sewers.

7. The only remedy for the removal of the injurious effects of inhaling poisonous air derived from the sewers and middens, would be to prevent the formation of noxious gas—firstly, by intercepting the solid contents of the water-closets, by having a suitable receptacle, to be removed every day, or every other day. Secondly, to remove all open ashpits and middens both from courts and private houses; to have a receptacle to each privy large enough to contain all excreta, ashes, and vegetable refuse, and to have its contents removed daily, or every other day. The ashes would in a great measure take the place of dry earth.

By this means you would prevent the admission of animal excreta into the sewers, thus rendering the air more pure. You would prevent the contamination of the wells by the fact of there not being any ashpits to supply nitrogenous matter. You would have manure of some value, and by doing away with the ashpits you would have increased building space, in lieu of a hot-bed of decomposing animal and vegetable substances.

I am, Sir, your obedient Servant,

JOHN DARWEN,
District Medical Officer of the Parish of Birmingham.

G. S. Mathews, Esq., Secretary to the Sewage Inquiry Committee.

83, Newhall Street, Birmingham, July 25th, 1871.

Mr. Chesshire

SIR,—I beg to submit the following replies to the special questions you have addressed to me, relative to the effect on the public health of sewer gas emanations, &c., with a few suggestions as to the best mode of remedying the evils arising therefrom, which I shall be obliged by your laying before the "Sewage Inquiry Committee."

I am, Sir, your obedient servant,

EDWIN CHESSHIRE, F.R.C.S.E.,
Senior Surgeon to the Birmingham and Midland Eye Hospital.

To G. S. Mathews, Esq.

1. The gases which emanate from sewers and drains (especially the latter) being composed chiefly of sulphuretted and phospohretted hydrogen and ammoniacal gases, are such as indicate, in a marked degree, putrefactive decomposition of animal excreta, which unquestionably arises from water-closets being connected with drains and sewers, the *solid* matter from which lies in the drains beneath the dwellings, and there produces elongated cesspools of the most dangerous description, as may easily be proved by opening, in dry weather, a few drains in the borough into which water-closet soil-pipes empty themselves; and I would suggest that the residences of the Chairman of the Public Works Committee and of the mover of the resolution for the appointment of the "Sewage Inquiry Committee" should be the first examined, as the disgusting cesspools there discovered would induce those gentlemen at once to become converts to the principle of primary interception.

2. I have observed this in numerous instances, and many such cases have been recorded in the medical journals. This remark applies also with equal force to the contamination of wells within the borough by soakage from the sewers and drains when clogged with solid matter; and I believe I am correct in stating that your officer, Dr. Hill, read a paper at the Social Science meeting in this town, "On the Pollution of the Wells of the Borough." I am decidedly of opinion that *all* bog-holes and dumb wells, *without exception*, as at present constituted, drain themselves by percolation into wells adjacent to them.

3. The effect of the escape of sewer gases through water-closets, sinks, and waste-pipes into the interior of dwellings is productive of a low state of health, inducing in the residents a kind of chronic typhoid condition, which, in the event of a serious illness of *any kind whatever*, renders the case peculiarly prone to a fatal termination. This is well exemplified in all large institutions, such as public hospitals, where there are always a great number of waste-pipes and other connections with the closet drainage. In such hospitals, it is a recorded fact that the deaths from amputations alone are four times as numerous as from similar operations per-

formed in the poor man's cottage. A striking instance of this evil occurred at the Saltley Training College, where it was found necessary to sever the connection with the drains on this account, and I believe the same disconnection still exists.

4. The emanations from open privies and middens in crowded courts, as at present constructed, tend to propagate and extend all diseases of the zymotic class.

5. Answered by No. 2.

6. I am of opinion that all diseases of the zymotic or epidemic class are propagated by the above-mentioned causes, but cholera, diarrhœa, and typhoid fever are especially so.

7. I am distinctly of opinion that the principle which involves the interception of the *solid* portion of the excreta (with as much of the liquid as possible) *before* it has entered the sewer, and *before* it has been placed under the influence of the rainfall, is the *only* principle which can possibly overcome the above-mentioned evils. The *solid* portion of the excreta in dry weather clogs the drains and then undergoes putrefactive decomposition, and being of a sticky or glutinous nature would certainly remain in the drains, sewers, and river, and not get farther than Tamworth for an indefinite period, while the liquid escapes freely, and would, if not intercepted by the solid, pass with the other liquid sewage through the sewers and rivers, and in four-and-twenty hours be in the sea; but if it is thought advisable to retain the urine from dry closets, as it is twelve times greater in bulk than the solid excreta, I should advise that it be caught in a second receptacle, such as a common barrel, in which a tap may be placed for the urine to be drawn off at intervals, or the barrel itself, when full, may be removed entire, and an empty one substituted.

Sewage Inquiry Committee.

Borough Prison, Birmingham, July 25, 1871.

Dr. A. Hill.

Gentlemen,—In answer to your invitation to furnish replies to certain questions on matters affecting public health, I beg to hand you the following, and shall be happy to furnish you with fuller information, should you require it.

I beg to remain, Gentlemen,
Your obedient servant,
ALFRED HILL, M.D.

1. The character and constituents of sewer gas indicate the presence and putrescence of animal organic matter in the sewers. This animal organic matter is derived from various sources—slaughter-houses, tanneries, cat-gut factories, stables, privies, middens, cow-houses, pigstyes, droppings of horses and other animals, and the urination of persons in all parts of the town, and of course also from water-closets. There is no doubt, therefore, that the *quantity* of sewer gas results, to a great extent, from the connection of the sewers with water-closets, privies, ashpits, and middens; but its *quality* would be much the same if there were no such connection.

2. I have in hundreds of instances observed, and proved by chemical analysis as well as by direct inspection, that wells situated near ashpits and middens, whose water is used for drinking and domestic purposes, are contaminated to a very serious extent by drainage into them from such ashpits, middens, privies, &c.

3. The effect on public health of gases escaping from sewers into dwelling houses through drains, water-closets, &c., is often, and as a rule, too gradual and insidious to be clearly and directly traceable; but the observant medical practitioner has no difficulty in many cases in tracing low diseases and low types of disease to gases escaping from the drains and sewers, and gaining access to the interior of houses. This is often discoverable by the offensive odour of the gases when they are sufficiently concentrated. On the withdrawal of such atmospheric contamination, low diseases alter in type, and zymotic diseases disappear. I have known cases of men opening drains being suddenly taken ill with serious symptoms of vomiting, prostration, pain in the bowels, diarrhœa, followed by nausea and debility for days. I have also witnessed an instance of a whole household being made suddenly ill by a current of air rushing from the sewer through a sink-drain. The odour of the gas was unmistakable, besides which the gaseous current *out* of the sink-pipe *into* the house was found to be sufficiently strong to extinguish a candle-flame held at the

Appendix II. — Dr. A. Hill.

orifice of the pipe. No sink or house drain should ever communicate *directly* with the sewer, not even when trapped, but always by an interrupted as well as trapped channel.

4. I have no hesitation in expressing my belief, founded on observation, that privies, ashpits, and middens drained into sewers, are less inimical to public health than they are when not drained.

5. The effect on public health of water contaminated as above is very unequal. Sometimes bad water may be drunk for a long time, apparently with impunity; at others it clearly causes illness, and aggravates that already existing, exciting and intensifying a variety of diseases of the alimentary canal, as well as those depending on vitiation of the blood.

6. My experience leads me to believe that cholera is directly traceable, in many instances, to bad water; and that small-pox, scarlet fever, and other diseases of the zymotic class, are promoted and aggravated by its use, as well as by the pollution of the atmosphere by the gases from drains, sewers, and all other sources of animal exhalations.

7. As a means of diminishing such toxic influences, I would recommend briefly—

(*a*) Severance of direct communication between the interior of houses and sink drains.

(*b*) Flushing of sewers at proper times, so as to prevent accumulation of putrescent matters.

(*c*) The maintenance of sewers in good order, so as to facilitate the flow of sewage and obviate the formation of pits.

(*d*) All privies, ashpits, and middens, to be sheltered from sun and rain, and prevented from leakage into the surrounding earth by being perfectly cemented, and that they be well drained; also, that ashes be carefully thrown into privies and middens for the purpose of absorbing the gases evolved by decomposition.

(*e*) The closing of all wells, proved by analysis of the water to be contaminated by excretal and other animal impurities.

(*f*) Ventilation of the sewers by air-shafts, if such a plan be practicable, in order to establish and maintain upward currents into the higher air, and prevent minor currents of sewer gas passing out of gullyholes and drains into streets, courts, and houses.

Dr. Johnston

1. It is a fact, that a number of gases do escape from the sewers. The great bulk of such sewer emanations consists of impure or vitiated atmospheric air and watery vapour. Air, during its passage through the sewers, gives off a portion of its oxygen to the decomposing animal and VEGETABLE matters, leaving an abnormal mixture of nitrogen and oxygen. We may, and do, in this manner account for the free nitrogen, if not for some of the other gases. Free ammonia, sulphide of ammonium, sulphuretted-hydrogen, and carburetted hydrogen gases, are also present.

Some of these gases indicate the *probable* presence of decomposing animal matters in the sewers, but cannot indicate whether such animal matters, when present, are derived from privies and water-closets, or from the drains of slaughter-houses or other trade premises, seeing that one of the most noxious—the sulphide of ammonium—will be formed in any drain where lime and blood and sulphuric acid meet together, a concurrence most likely to occur on manufacturing premises. We are also certain that a great portion of the peccant gases have their birth-place in the leaky gas mains lying in juxtaposition to the said sewers.

2. I have frequently found the water of wells, situated in the vicinity of privies and ashpits, seriously affected by the drainage from such middens. This I have found most frequently in new streets, previous to the formation of proper sewers by the Corporation. In many such streets the foundation of the houses is artificial, porous, new-made ground, and the well naturally a drain for any fluid matters of the surface. If the midden is well constructed and freely connected with the sewers, I have known a well to contain perfectly pure water, even in the same yard with such middens.

3. If the house is well ventilated, the amount of gases escaping from ordinarily well trapped drains is not of any material importance, as the diffusion of gases takes place so rapidly; but, if the house is badly ventilated and closely shut up at night, it then becomes a vast isolated receiver, and persons habitually breathing such vitiated air cannot keep up the normal vitality and are then unable to throw off

the effects of zymotic diseases; in fact, their bodies are capital nurseries for nourishing any such fomites. If sulphuretted hydrogen be present it will ultimately cause anœmia, by its action upon the blood, and all its train of evils.

4. Open privies and ashpits in well-ventilated yards, if *well drained* into the sewers, do *not* affect the health, as the coal ashes absorb gases and prevent odours, excepting at the time when they are disturbed for removal; but if these middens are situated in close courts and if they are badly drained, then you have gradual loss of vital power among the inhabitants. This is especially noticed among the women and children who are exposed to its influence day and night, whilst the men are away the greater part of their time in the healthy workshop. In these courts we always find an increased death rate among the children, as they have not the vital power to resist epidemics, much less to throw off the sequelæ of such epidemics as measles, scarlet and typhoid fevers.

5. It has been proved to my satisfaction, that water impregnated with the simple excreta of healthy animal life, and freely exposed to the air, will *not* produce any baneful effects upon those drinking and making use of such water. But the same excreta are liable to *various* forms of fermentative decomposition, under the varying circumstances of place, quantity, heat, and atmospheric electricity; the results of such fermentative changes being various in character and in effects, always prejudicial upon the human body receiving them; and I believe that the most common way by which they gain access to the body is by the water impregnated by such midden drainage. In my opinion, some of these resulting products may produce simple fever, erysipelas, enteric or typhoid fever, and even typhus and cholera, at the same time that I believe the majority of such cases are epidemic rather than endemic, *i.e.*, that an exciting cause is brought from without, but finds in the bodies of those with low vital powers a suitable nidus for propagation.

6. My experience leads me to believe that I have seen cases of typhoid fever, of measles, of scarlatina, of erysipelas, which have been purely endemic, and most probably due to the aforesaid agencies. At the same time I must admit that I have no positive proof of this; but I have positive proof that a vitiated atmosphere and contaminated water do weaken the vital power of the people, and that when so weakened they succumb more readily to the attack of any epidemic disease.

7. Believing, as I do, that the sewers afford the best, if not the only means for removal of excreta, &c., from the town, and thinking that the after disposal of such sewage is a distinct subject, I shall only mention a few points respecting the present system of drainage, which I think are essential to its perfect action. A number of trusty men or inspectors should be appointed to visit each house, &c., and see that the drains are properly connected with the sewers, and properly *kept in order*. I think, that lofty pillars, towers, or chimneys should be placed at certain points of the main sewers, with gas constantly burning, which would cause all the currents to run from the house drains, and from the open street drains to the point, instead of allowing them to be swept up into the houses and streets by a current naturally originating at the lower point at Saltley. This can only be carried out by making large syphon outlets at Saltley—that is, by trapping the *outlet*, instead of only trapping the small and numerous points in the towns. These syphons, immense in size, would arrest much of the solid matters, and allow a fluid to flow more fitted for irrigating purposes. In cases of sudden rain or flood, there should be a means of exit provided, independent of the syphons, which would probably be half stopped up under a flood by the solid.

As regards the disposal of the sewage, I believe that ultimately the town will be obliged to buy farms or lease them for irrigation. This may be done to a profitable issue.

JAMES JOHNSTON, M.B. London.
Physician to the Queen's and Children's Hospitals.

9, Easy Row, 3rd August, 1871.

Birmingham, August 12th, 1871.
Allan House, Steelhouse Lane.

To the Sewage Inquiry Committee.

Gentlemen,—I have to acknowledge the honour of a communication from you, requesting information pertinent to the inquiry you have in hand, and beg leave to forward the following replies to the queries propounded :—

Appendix II.
—
Mr. Clay.

1. There is no doubt that the gases escaping from the sewers are derived chiefly from animal excreta, and as the introduction of these substances into the sewers from any other source than middens, water-closets, &c., is of the smallest extent, it is fair to presume that they are derived mainly from water-closets, &c., being connected with the sewers.

2. I have no doubt that the water in all the wells in Birmingham, with the exception of the artesian wells, is contaminated more or less, and in some wells to a great extent, by animal substances introduced into them by percolation, and as these animal substances can only be derived from ashpits, middens, and imperfect drains, there can be no inconsistency in assigning the impurity of the water to these sources. I have long entertained the opinion that all the wells in Birmingham excepting the artesian wells, ought to be closed.

3. I have known many instances where diphtheria has occurred in houses in which an improperly ventilated water-closet existed. In some of these instances I have ascertained with tolerable certainty that the emanations from the closet were the sole cause of the disease. I have known several cases of typhoid fever to arise with tolerable certainty from a similar cause.

4. I have long been of opinion that ashpits and the privies connected therewith, where they are well drained, are not, *per se*, nearly so prejudicial to public health as ill-ventilated water-closets. This immunity is owing, to a great extent, to the animal excreta being covered with ashes and other solid material, and I have noticed that the innocuousness of these places has been in proportion to the completeness with which the excreta have been covered, especially in those instances where through indolence the ashes have been occasionally thrown down the holes in the privy seats, directly on to the excreta. Another reason of the comparative inoffensiveness arises from the fact that such places are generally open to the atmosphere, and the gaseous emanations being thus carried into the air, become eventually infinitesimally diluted. Hence I have always opposed covered ashpits. I have known fatal cases of disease induced in the people working in shops which have been built over middens. I may mention also the special immunity of the old night-soil men from disease. Many years ago I was surgeon to a club of night-soil men. I refused at first to entertain the idea of being their surgeon, expecting that I should have a good deal of work for the pay. The remuneration first proposed being increased, I accepted the contract, and the society was the best paying one that I ever held. In three years I had not more than half-a-dozen cases to attend to, and these were all of an accidental nature. I offer no explanation of these facts, but it was somewhat singular that these men had such a freedom from sickness, when half their lives was spent in following what is generally considered to be a very unhealthy occupation. The effect from these causes on the public health of the town will therefore be greater in proportion as the obstacles to the dilution of the gases arising from the pits and their ventilation are increased by overcrowding of the houses in their neighbourhood, and especially where the ashpits are undrained. Of course, if these *foci* of foul air prevailed to a great extent without adequate means of dilution, the atmosphere of the town, already extensively vitiated, would become dangerously so to the inhabitants residing in it.

5. Drinking unboiled water, contaminated as mentioned in Question 2, would not affect the public health, as only those partaking of it would suffer. In these instances diarrhœa, cholera, and typhoid fever are the diseases which have been most frequently observed to arise from such a cause.

6. There is no doubt that the diseases here mentioned, with the exception of cholera and typhoid fever, cannot be directly or indirectly traced to the causes referred to in the circular.

7. This is a large question, and I shall be obliged to answer it very briefly. One thing I may perhaps be allowed to say to the Committee—that if the interests of the medical profession are consulted, they will strongly advise the present system to be continued. On the other hand, if such alterations in the sanitary arrangements be recommended as may tend to abate the injury to the public health from causes herein enumerated, then I trust the Committee will be prepared to suggest to the Council that a rate be levied of sufficient amount to compensate the medical profession for the loss they would sustain by the adoption of such sanitary measures as they may recommend. There is no doubt that the animal excreta should be excluded from the sewers. The acids so much talked about and feared should be retained as far as possible, as they are very beneficial in fixing to a large extent any noxious emanations which may arise from the sewage. Although, if animal excreta were excluded from the sewage, the emanations would not be so large, still they would prevail to some extent. The acids, in case of irrigation with the sewage fluid, would be of service in constituting and giving important salts to vegetation, and they would tend to lessen the offensive exhalations at the "sewage outlet." Iron ought to be positively excluded from the sewage, as it has a great affinity for some of the acids, and would be highly poisonous to vegetation if the sewage containing it to any extent were applied

Appendix II. — Mr. Clay.

to growing crops, as, once deposited in the soil, it is only removed by them in very small proportions; and it is possible to conceive that by constant deposits of sewage matter containing iron, the soil would be unfit for the higher classes of vegetation. Earth-closets are the principal, if not the only means of excluding animal excreta from the sewers. These should be erected outside a house. I think earth-closets inside a dwelling house, even with the greatest supervision, would become nuisances in time, and dangerous to health. I should prefer water-closets in a house, as by ventilation and regular flushing many of their dangers would be lessened, but then they would not be conducive to the public health, on account of the introduction of injurious material into the sewers. I am of opinion that there is a gradual escape of gaseous matters from the sewers, and that certain deposits occur from these in and about the water-closet, and, in damp states of the weather, cryptogamic vegetation is developed, and that these growths become detached by various processes, and give rise to certain forms of disease. This may not be the true explanation, but I have observed that after damp weather the illnesses previously referred to prevail then more than at other times. I can easily imagine that emanations, although not in so great proportions as escape from water-closets, would arise from earth-closets erected inside a dwelling house, and they would in time be likely to give rise to some injurious vegetative growth and produce disease in the inmates. Earth-closets in a house would be more troublesome to the female portion of its residents, such as would be caused by the inconveniences arising from filling the receptacles with earth, carrying the excreta away, although probably inoffensive in itself, yet the proceedings, like a washing day, would be considered in a family an event, and not likely to be immensely popular with the mistress of the house. I think that the sewage question ought to be a national sanitary question, and might then be satisfactorily dealt with. In the present state of the Birmingham sewage question it appears to me that a combination of several plans will be necessary to meet the difficulty—removal from the sewage of animal excreta by earth-closets being of the first importance, exclusion of iron from the sewage, catch-pits, and irrigation, being of minor importance, principally subsidiary in dealing with the residuum as a means to the end. I have to apologise to the Committee for this imperfect report, but my time being just now excessively occupied must be my excuse.

I am, Gentlemen,

Yours obediently,

JOHN CLAY.

Dr. Jordan.

Dear Sir,—The paper came when I was away, else I should have replied to your letter sooner. I have not much to tell you, yet what I have noticed is at your service.

I am, dear sir,

Yours truly,

35, Harborne Road, August 2nd. ROBT. C. L. JORDAN.

1. The gases I have noticed have been ammonia, sulphuretted hydrogen, and sometimes chlorine.

The ammonia and sulphuretted hydrogen, of course, come from drains. The chlorine must have been put in for the purpose of purification. I have noticed these at night from the gratings by the roadside, and also in private houses.

Sometimes I have been consulted about the escape of gas in private houses.

2. I have often been asked to look at well water. Once or twice there has been organic matter in some abundance; generally iron has been the cause of the fright.

3. The effect *must* be lowering, because the inhalation of sulphuretted hydrogen always is so, but I have never noticed this. The houses with water-closets are, as a rule, too well ventilated for much mischief.

4. Here often very disastrous cases have come under my care. Typhoid has put on a very malignant type in such cases. When my work lay more amongst the poor than now, this has been constantly noticed by me. One spot remarkable for an open drain near it was so infamous for typhoid that I used to call it always "Fever Court."

5. Has never fallen under my own immediate notice.

6. My own opinion would be that the infectious matter, both of typhoid and cholera, was chiefly in the excreta from the bowels. I have again and again, when typhoid was in a court, warned the mothers against letting the children play over an open drain, and prophesied the result, which has often come true. All excreta from an infected person can probably communicate disease, but in small-pox and scarlet fever the stools are not, as in typhoid, the usual plan of communication. Scarlet fever becomes *much mors* malignant in an ill-drained court.

Appendix II. — Dr. Jordan.

7. The remedy is to remove the cause and adopt a more perfect system of drainage. But the plan so often used in Birmingham, of having only one narrow inlet to a court (which thus has no through current of air), is, in addition, a very injurious one.

Dr. Fletcher.

7, Waterloo Street, Birmingham,
July 24th, 1871.

Sir,—The questions the Sewage Inquiry Committee have submitted requier much time and attention to answer fully. I have, however, given you short answers in accordance with the numbers, which may be sufficient for you to form an idea of my views.

1. No doubt of the fœcal odour of gases from sewers.
2. Yes, several times, and I have lately lost a friend from this cause.
3. Lowering the general state of health, and producing diarrhœa and fevers.
4. Ditto.
5. Ditto.
6. Epidemic, contagious, or infectious diseases are conveyed from one part of the town to another by the gases escaping from the sewers which carry fœcal matters.
7. Collect the fœcal matters at their sources in well trapped and cemented reservoirs.

I hope this will be sufficient for the purpose of the Sewage Inquiry Committee.

Yours very faithfully,

BELL FLETCHER.

G. S. Mathews, Esq.,
Secretary to the Sewage Inquiry Committee.

Mr. Clayton.

1. As the sewers contain large quantities of human excrement, and as the sewer gases are the products of animal and vegetable decomposition, they probably, in a great measure, arise from the contents of the water-closets passing into the sewers; though if these were excluded the sewer gas would still be very injurious.

2. I have never found water from any wells in Birmingham (which are almost all surface wells) anything like pure. The general report given on analysis by Dr. Hill is that they are contaminated with sewage, and unfit for domestic use.

3. Nothing is more injurious to health than the escape into dwelling-houses of the sewer gases, especially when the house is shut up at night or is ill ventilated. These gases pass into the house from different points; they may draw in from the outside, under the roof, from the water-spouts communicating with the sewers, through a drain in the cellar, the back kitchen and china pantry drains, &c., and from the overflow pipe in a bath, and one in the water-closet supply cistern (which is generally inside the house). These two latter usually run untrapped into the soil-pipe of the water-closet. Gases thus admitted are the fruitful cause, in my experience, of ulcerated mouth and fauces, diphtheria and croup, indigestion and vomiting, diarrhœa and dysenteric diarrhœa, uterine irritation, erysipelas and skin affections, cholera, typhoid fever, and poisoned states of blood generally. All these have been removed from houses where they habitually existed, by the severance of the connection with the sewers and the use of pure water.

4. Where there is an open space and a large quantity of ashes to mix with a small amount of excrement, I think privies and middens less injurious than the admission of sewer gas into the house; but nothing can be worse than the state of the privies in many of the close courts of the town, full to the top of the seat, and overflowing with a seething and fermenting mass of undiluted excrement, soaking into the ground, to find its way into the nearest well. In my opinion, open privies and dumb wells are incompatible with pumps in this town.

5. I have found that water contaminated with sewage matter produces diseases of a similar type to those caused by sewer gases; cholera and typhoid fever more especially so, since in these the excrement is the chief carrier of the disease.

6. In *many* of these diseases *decidedly so.*

7. With respect to the water, I would mention that in over 20 years' experience I have never found any injurious effects result from drinking waterworks water; on the contrary, I have found beneficial results follow its substitution for well water. I would therefore suggest that the Corporation should supply the town with water, and that as the wells are almost invariably fouled, they should obtain compulsory powers

of closing them all. This is essential, because persons drink by preference impure water because it is often brighter, more sparkling, and colder; in limestone formations the water is sparkling without being injurious; not so in the red sandstone—this property is then due to sewage contamination.

With regard to the drains; all water-closets ought to be outside a house, or at least semi-detatched, with a well-ventilated passage between them and the house, if they must be in a house. Then there should be an extra trap at their entrance into the sewer, and a ventilating pipe should run from the soil-pipe to the top of the house; water-closets should be, if possible, substituted in the courts, &c., of the town for open privies; all communications with premises and the sewers should be made with sanitary pipes well cemented at all the joints; and, lastly, all communication should be broken between the inside of the house and the sewers by a simple, inexpensive, efficacious, and common-sense plan—viz., bring the sewer only up to the outside wall of the house, terminating there at a trapped grating, and then let the drains of the house pour their contents on to the top of this in the open air, by which means no gas from the sewer can possibly enter the house when it is closed. These are all the suggestions I have to make, and I am sure they are all sufficient to diminish, not only the bills of mortality, but the doctors' bills.

It is fortunate for the poor that they have no drains in their houses, and it is to be hoped that they will never continue the sewers into them; for if they do, the results in close, ill-ventilated houses which are over-crowded will be fearful. With bad air and impure well water you cannot have healthy nutrition; disease *sui generis* is produced, slight diseases and trivial epidemics are converted into a pestilence, and the moral and physical characteristics of the population deteriorated.

M. D. CLAYTON.

58, Calthorpe Road, July 28th, 1871.

TO THE SEWAGE INQUIRY COMMITTEE.

Gentlemen,—I am in receipt of your inquiries as to the effects of sewage upon the public health, and in reply beg to state—

1. I have never collected for examination any of the gases which escape from or are contained in the sewers in this town; but, judging from the odours which arise from untrapped drains in and about dwelling houses, and opening into the sewers of the town, together with the action of the gases escaping upon white paint, there can be no doubt that sulphuretted hydrogen and ammonia, two of the products of animal decomposition, enter largely into their formation.

2. This question is of no practical utility, for the reason that water in wells may become impregnated with deleterious matter, and yet remain to all appearance perfectly pure. I have not attended or seen diseases which could be directly traced to this cause, but have had many attributed to it. The solution of this question requires statistics of disease on a large scale, with special observation on the sources of water supply.

3. The effect is to render the system less able to resist, and to become more susceptible to disease. Any disease which is epidemic or contagious becomes localised and intensified from this cause. Upon this point I am quite confident, having repeatedly traced the proclivity to diseases in families who have been subjected to the escape of gases from sewers into their dwellings.

4. I have not seen any decidedly bad effects arising from the system of open privies, ashpits, and middens, except in a few instances where they were in too close proximity to the dwellings, and were the receptacle of every kind of refuse, both animal and vegetable. In such instances diarrhœa and fevers have been prevalent, but my acquaintance with the courts of this town, professionally or otherwise, is not such as to make my opinion on this question so valuable as it might be.

5. The injurious effects upon the public health, of water contaminated by the drainage from middens, &c., admits of no question; and, although not so frequent a source of water pollution as drains, yet, so far as it does exist, it is equally prejudicial to health.

6. I can positively affirm that the susceptibility of persons to these diseases, if not the originating causes of the disease, is directly traceable to poisonous gases manating from open sewers, middens, &c., and to the use of water, for drinking and domestic purposes, contaminated from the same sources.

7. The water supply of towns should be remote from dwellings, and should not e obtained from streams which pass through and receive the drainage of thickly opulated districts, for, when once contaminated, no system of filtering will render it pure. I should therefore recommend the supply, if possible, to be obtained from

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wells sunk to such depth, and so far from all sources of pollution by drains, as to render the purity of the water certain. In respect to the escape of gases from the drains into houses, all drains should be trapped *in and about* dwellings, and this should be made compulsory with landlords. The ventilators of the sewers should be placed as far distant from dwellings as possible. All ashpits and open privies should be frequently emptied, and not made the receptacle for foul water, but *kept as dry as possible.*

I am, Gentlemen,

Your obedient servant,

49, Broad Street,
July 31st, 1871.

BENJAMIN HUNT, M.D.

Dr. Warden.

Dr. C. WARDEN, Hon. Surgeon to the Lying-in Charity, writes :—

1. I am of opinion that they do.
2. I have on many occasions.
3. Low fevers, ulcerated throats, and other effects of poisoned blood too numerous to detail.
4. If ashpits are left open at the top and covered from day to day with ashes and cinders, and not drained into the sewers, the effect on public health would be as little injurious as possible. They ought *not* to require any drainage if properly constructed.
5. *Most deleterious.*
6. Without a doubt.
7. I am of opinion that no house should communicate by pipes or drains of any kind *directly* with the main sewers, but that pipes should convey "slops" or water from sinks outside the house into a short open gutter and thence into a drain, which should be connected with the drain by a properly constructed stench-trap, one that would always contain water several inches in depth, and not liable to get out of order easily, as is now the case with nearly all in general use, especially in the low courts in the town. I believe water-closets to be a *huge error*, as at present constructed, and I would substitute for them the dry earth-closets, with a division, the *anterior* chamber of which should catch the urine, the *posterior* the solid excrement, which latter should contain soot, and be emptied as often as convenient; the liquid urine to be conveyed to a larger tank or vessel kept in the open air, as far from the houses as possible, and the solid portion in another receptacle by the side of it. Both would form most valuable manures for the land. Arrangements might also be easily designed for catching the urine of horses in stables, pig-styes, &c.

I am of opinion that the ventilation of sewers is very incomplete, and, as far as I can judge, the system of ventilation by the street lamps appears to be the best; and if well carried out, the lamps being made sufficiently high, I believe it would be effectual. At present the sewers are ventilated by the houses, a system fraught with the greatest danger to health and life. With regard to the construction of houses generally, I am of opinion that it is fundamentally wrong. I would suggest that no house should be permitted to be built without a cellar under every room, and no room should be less than a certain height, and with regulation ventilators near the ceiling of every room; no house to communicate under the same roof with dusthole, as is now commonly the case; in fact, dustholes often have sleeping chambers over them. If dustholes have a roof at all, it should be a very high one, open all round, to admit air, the roof being simply to keep it dry.

Mr. Solomon.

96, Newhall Street, Birmingham,
August 24, 1871.

Dear Sir,—I am entitled from personal experience to state that fever is produced in some instances by the drinking of water contaminated by filtration from an ashpit; also that a low state of health is induced by the prevalence in houses of gases emanating from water-closets.

I am, dear Sir,

Yours truly,

G. S. Mathews, Esq.

J. VOSE SOLOMON.

Appendix II.

1 and 2. Only a practical analytical chemist could give exact information upon these questions.

Mr. Bracey.

3. Sewage gas escaping into the interior of dwellings produces among the occupants loss of appetite and diarrhœa. Typhoid fever may be an indirect result of it.

4. They tend to aggravate ordinary ailments, and to render an epidemic more severe.

5. Water contaminated with sewage (when drunk) causes diarrhœa; and, under certain circumstances, may be the means of communicating cholera and enteric fever.

6. Typhoid fever and cholera may be indirectly traceable to such causes; they are not directly so caused. Other diseases of an epidemic nature assume a more severe form when these causes are present.

7. Frequent and compulsory application of disinfectants to ashpits, middens, &c. Some plan of interception for the water-closets, so that the solid material shall not enter the drains. Mr. Chesshire's plan, in use at the Eye Hospital, has worked satisfactorily.

July 29, 1871. ARTHUR BRACEY.

Mr. Townsend

Sir,—I am sorry that illness has prevented my briefly replying earlier.

Yours truly,

C. TOWNSEND,

Honorary Surgeon to the Eye Hospital, and formerly Medical Officer of Health for the Borough.

1. Undoubtedly.
2. Frequently.
3. I have, and consider them highly injurious.
4. Always dangerous.
5. Bad.
6. I am surprised that a doubt can be entertained.
7. By interception from the sewers only do I think this great evil can be overcome. I will not venture to say how it can be best accomplished.

Mr. Green.

1. The gases escaping from the sewers through the gratings, in various parts of the town, have just the smell of a foul water-closet, due, no doubt, to the presence of animal excreta.

2. *It is well known* that well water is often contaminated to such an extent, by the vicinity of foul drains, as to be totally unfit for drinking purposes.

3. And that gases escaping into dwelling houses from sewers, or badly constructed water-closets, are a frequent source of disease.

4. And equally so the exhalations from open privies and middens in crowded localities.

5. There are proofs existent of the propagation of contagious disease, cholera for example, by contaminated well water.

The worst outbreak of Asiatic cholera which has occurred in Birmingham took place among the male insane patients at the old Workhouse, in the autumn of 1849, and arose from opening a foul drain which ran across their exercise court, a small inclosed yard from whence there was no outlet for the foul air to escape. Altogether twelve patients were attacked, all within a few hours of each other, six of whom died.

7. This is the most difficult, indeed the only difficult, question to answer. It appears to me that the first step should be the rectification of the gigantic mistake of pouring the whole contents of the water-closets into the main sewers. As to the use of disinfectants, their efficacy is at least doubtful, for it has never been proved that the removal of the smell of a poisonous gas deprives it of all its deleterious qualities.

THOS. GREEN,

July 21, 1871. Medical Superintendent of the Borough Lunatic Asylum.

Mr. Suckling.

St. Mary's Square, July 21, 1871.

Dear Sir,—In answer to your printed special questions which you have put to me through the post, I beg to reply as follows:—

1. Decidedly they do.
2. I have.
3. Highly injurious; the chief cause of the contagious diseases.

Appendix II.

Mr. Suckling.

4. If such ashpits and middens are drained into the sewers, no doubt the exhalations from the latter are prejudicial to the public health.

5. Highly injurious.

6. It does.

7. The free employment of disinfectants, the flushing of the sewers frequently, together with other well-known means, if the present system of sewage is to be continued.

I am, Sir,
Your obedient servant,

G. S. Mathews, Esq. C. D. SUCKLING.

Mr. Goodall.

Penmaenmawr, North Wales,
25th July, 1871.

TO THE SEWAGE INQUIRY COMMITTEE.

Gentlemen,—In answer to your circular addressed to me on the 18th inst., I beg to inform you that I have very little to offer in the way of medical experience respecting illness caused by gases exhaling from the sewers, and even less in the way of suggesting remedies for the evils arising therefrom.

Still I have long felt that the connection of water-closets, &c., with sewers is a great evil, but my experience has been gained so slowly and irregularly, that beyond leading me to seek for the remedy at the time of its occurrence, I have stored up no facts which entitle me to speak with any authority on the subject. I will, however, as you request, go through your questions, and give any information which I can.

1. From the water-closet and the "traps" in my own and other houses, I have frequently, especially in hot and dry weather, noticed the gases escaping to be most offensive, and of the character which could alone be accounted for by their connection with the sewage as at present constituted.

2. I have not.

3. I have long recognised that certain affections of the throat, which are characterised by exudation or ulceration, commonly called diphtheritic, are prevalent in houses where there is direct communication with the sewers. I believe this experience will be borne out by that of other medical practitioners.

4. I have no evidence to give on this head.

5. I have no direct evidence to give on this head, though I believe it to be eminently injurious.

6. I have no experience which would enable me to speak positively on this head.

7. Having paid little attention to the subject, I do not feel justified in offering suggestions, knowing that others have made it a subject of study, and will be able to give valuable help.

If it had been in my power, I would gladly have given more information on all the important questions you have submitted to me, but the subject is a difficult one, and my experience in regard to it is very limited, owing in great measure to my practice lying for the most part in the well-drained and well-ventilated parts of our large town.

I remain, gentlemen,
Your obedient servant,
W. P. GOODALL.

Mr. Berry.

11, Newhall Street, Birmingham,
July 24, 1871.

TO G. S. MATHEWS, ESQ.

Sir,—In reply to the questions of the Sewage Inquiry Committee, I have known disagreeable effluvia from the grating of the sewers, when open; and this has been especially observed by me in very dry weather, or when the sewers have not been efficiently flushed. The effluvia escaping from the sewers will be rendered more dangerous if the secretions from patients suffering from contagious diseases, and the water in which their linen has been washed, are allowed to enter the sewers. In my own house, in Newhall Street, the water in my well-pump has been so contaminated by drainage into it as to render it totally unfit for drinking and other purposes, and we have been obliged to use the Waterworks Company's water for some years. Whatever tends to render water impure, whatever tends to impregnate the atmosphere with morbid effluvia, are sources of disease, and the disease will take the direction from whence the effluvium arises, be it small-pox, scarlet fever, or other epidemic disease.

I remain, Sir,
Yours respectfully,
SAMUEL BERRY.

Mr. West.

22, Broad Street, Birmingham,
July 26th, 1871.

Dear Sir,—I have waited some days before replying to your circular of the 18th instant, in the hope that some public discussion of the important questions to which you have drawn attention might have taken place. I cannot doubt that much good would accrue to the town by the investigation of this question by the medical gentlemen whose advice you have asked, but I fear that their *individual* answers may exhibit so much divergence of opinion, more particularly in reference to Question 7, that the Sewage Inquiry Committee will not be much advantaged. After a free discussion of the matter by the gentlemen in question, a vote should be taken as to the mode of disposing of sewage which has the most advocates, and the result of that vote might be transmitted to the Sewage Committee together with a statement of the reasons which induced the majority to advocate the adoption of the course which seemed to them to be most suitable for the requirements of the population and for the sanitary improvement of the borough.

Would it be possible for the Mayor to invite the attendance of the medical gentlemen you have already consulted at a meeting, to be specially called for the purpose, when the subject could be fully discussed? Possibly, a decision might be arrived at which would assist the Sewage Committee in the settlement of the arduous task they have before them.

With every desire to assist them and the community in the solution of the difficulty,

I remain yours faithfully,

JAMES F. WEST, F.R.C.S.,
Senior Surgeon to the Queen's Hospital.

G. S. Mathews, Esq.,
Secretary Sewage Inquiry Committee.

Dr. Fleming.

Temple Row, Birmingham,
August 12, 1871.

Dear Sir,—I beg to acknowledge the receipt of your letter requesting my views on the influence of imperfect sewerage on the public health.

I must regret that it is not in my power to comply with the wishes of the Committee.

The *general* bearings of this subject have been discussed very lately, and very fully, by several competent authorities, and I could not hope to add anything material on this head; while the examination of the questions, with *special* reference to Birmingham, in order to make my observations of practical value, would demand an amount of time which it is not in my power to spare from my professional duties.

I am, dear sir, faithfully yours,

G. S. Mathews, Esq. ALEX. FLEMING.

Dr. Wrightson

Nine Elms, King's Norton,
July 28th, 1871.

Dear Sir,—In answer to your letter of the 26th, and enclosed circular, I have had considerable experience in matters connected with sewage and its application to land, and also with regard to wells and well waters. I have made numerous analyses of *sewage;* of some of which I beg to enclose copy. I formerly, when I lectured on chemistry at Sydenham College, made a large number of analyses of well waters from various parts of the town and suburbs—probably more than a hundred—for various inhabitants of the town. They were mostly made with the object of "*seeing whether the water were pure,*" as it was stated to me; frequently it had happened that fever, diarrhœa, &c., had been prevalent, or perhaps only a bad taste or smell had been preceived in the water.

I always directed my attention to ascertain whether there was any contamination from sewage.

The presence of ammonia or nitrogen in some form has usually been considered to be sufficient proof of contamination from that source. I, however, always thought it necessary to search also for phosphoric acid (as alkaline and earthy phosphates), as that is always contained in "sewage," while nitrogen and ammonia are occasionally found even in pure waters, even in snow from the Alps. I am sorry I can give you no details of these analyses, because I have not preserved any record. They were made with a technical object, and had no scientific interest; but many years ago, perhaps twenty, I alluded to the fact in an article I wrote on

Appendix II. — Dr. Wrightson

"Pure Waters" in one of the local papers. But as few or none of the analyses were quantitative, the general result from memory may be perhaps as useful to the Committee, viz :—That the large majority of the waters by far, from the surface wells of the town and suburbs, brought to me for examination, afforded proof of sewage contamination, some to a large extent; the contaminating source had frequently been suspected, and could be traced, and it was often connected with illness or indisposition in the family. Several deep well waters I examined (for my own information,) viz., Digbeth and Summer Row pumps (my laboratory was over the latter at one time), were the purest waters I examined, and were free from sewage.

With regard to the queries propounded in the circular :—

1. The analysis of the deposit from the sewage collected near the outlet showing a large percentage of sulphide of iron, proves the existence of sulphurette l hydrogen in large quantity in the sewage. This may have been derived in part from certain manufactories, but is doubtless in great measure also from the same sources as the ammonia and phosphoric acid, viz., the water-closets, middens, &c. The question is therefore affirmed.

2. It is evident that I affirm this question also.

3. I believe the effect on health of an escape of gas from water-closets or drains to be most injurious, even in very minute quantity, inducing a debilitated state of the stomach and system generally, especially among women or children much confined at home.

5. I have already stated my opinion.

4, 6, and 7. I am not prepared at present to give direct answers to these queries, but might possibly have something to say on them at a future time. Meantime, I hope the brief results of what experience I have had on the subject may be of some use to the Committee in their arduous duties.

I am, dear sir, faithfully yours,

FRANCIS WRIGHTSON.

G. S. Mathews, Esq.,
Mayor's Office, Borough of Birmingham.

Temple House, Bath Row,
Aug. 30th, 1871.

Mr. Wilders.

1. Yes, and for this reason—that it has been found that organic matters and gases consisting of light carburetted hydrogen, nitrogen and carbonic acid, and sulphuretted hydrogen, escape from the sewers. Now, these organic matters and gases are essentially the products of the decomposition of animal excreta, and it is stated by both French and German writers that these deleterious vapours will pass easily through walls.

2. In two cases occurring in the immediate neighbourhood of Bath Row, I was consulted by the occupiers of the houses about their drinking-water. The water had a peculiar, and at times, very fœtid odour, and in one case it was stated that it caused diarrhœa. In both cases the wells were opened, and we could distinctly trace contamination from neighbouring ashpits. In both cases it was plainly to be seen that water had percolated from the ashpit, through the soil, into the well; in *one*, more especially, you could see a green, dirty, and slimy stream oozing down the side of the well. One of the ashpits communicated with a privy, so that the people were drinking animal excreta.

3. There are several cases on record in which typhoid fever has constantly prevailed in houses exposed to sewage contamination, and in which the stoppage of the communication of the drain with the house has at once removed the fever.

Now it may be said, in answer to this, that sewage air does not produce the lesion of Peyer's patches, which is the pathological change observed in true typhoid fever; nevertheless, the sewers are the channels through which the poison, derived from the stools of persons suffering from that fever, find their way into the houses. I believe also that sewage air causes diarrhœa, dyspepsia, and languor, as well as other affections of the digestive organs.

In one case that came under my notice, case after case of diphtheria continued to occur in a house in a most healthy locality in the suburbs of Birmingham. Numerous endeavours were made to discover the cause, the drains were trapped and other precautionary measures taken, but all to no purpose. At last it was discovered that the waste pipe of the water-closet communicated with an old pipe which was connected with a water-cistern in the roof, which had, however, been long unused and empty, and thus the sewage air had been constantly flowing back into the house. This com-

munication was cut off, and not another case of diphtheria occurred. This certainly looks like cause and effect. Appendix II.

4. I have always found in any courts where the state of things indicated in Question 4 exists, that diarrhœa (especially in hot weather) always prevails, that the children suffer from marasmus or wasting, and in reference to this latter, I have in my mind a court near to my house, in which I have seen several children die of this disease—in one, a small scratch on the face became a sloughing wound, and half of the face was eaten away before the child died. At the bottom of this court, which is very narrow and confined, there is an ashpit, into which the privies open, and which is always most offensive. The inhabitants of such courts very frequently suffer from diseases of digestion and sanguification. Even the children who escape disease are pale, miserable-looking, and stunted. Mr. Wilders.

I most unhesitatingly condemn this state of things, and often wonder why it is allowed to exist, as I never find that any disinfectants are used.

I may add another instance. Within the last month I have been attending two children in a court in which there was one of these ashpits, which smelt abominably. They both suffered from severe diarrhœa; medicines of all sorts, diet, &c., were tried without success. I advised the parents to remove them—the one did, and the diarrhœa rapidly ceased; the other remained, and died.

5. Water contaminated with animal excreta will produce *diarrhœa*, which is frequently of a very violent character, being accompanied by very severe vomiting, cramp, and collapse (*vide* case reported by Dr. Edmunds in the *Times* of last week, and which he thought to be one of Asiatic cholera).

Typhoid fever is also caused by the same cause (*vide* writings of Drs. Budd and W. Simon.)

Cholera has, in numerous and indisputable cases, been caused by this contamination. For further information on these points I would respectfully refer the Committee to the following works on the subject:—

"On the mode of Communication of Cholera." By John Snow, M.D.
"Report of Medical Officer to Privy Council, 1866." p. 224.—This water was contaminated by animal excreta.
"Cholera in Oxford in 1854." By H. W. Acland, M.D.
"Fœcal Fermentation." By Dr. Routh.

6. Typhoid fever, cholera, diarrhœa, diseases of digestion and sanguification I believe to be directly traceable to these causes. Possibly scarlet fever, diphtheria, and typhus fever are also referable to the same cause.

7. If the Committee should see fit to continue the present water-closet system, and allow animal excreta to pass into the sewers, (a system which I should much like to see altered into the dry-earth), or some method of interception of the solid excreta, I should strongly advise the constant use of disinfectants, such as chloride of lime, carbolic acid, chloralum. Solutions of these might be poured down the sewers, especially in hot weather. They might also be put into ashpits, middens, &c., by the servants of the Corporation, or supplied gratuitously to the inhabitants. I would call the attention of any member of the Committee to a sewer at the left-hand side of Calthorpe Road, close to the Five Ways, and he will smell how necessary these precautions are.

JOHN ST. S. WILDERS,
Surgeon to the Queen's Hospital.

The BOROUGH SURVEYOR reports with reference to the following Minute:— Borough Surveyor's Report.

"That the Borough Surveyor be requested to make a return of the number of 'nightmen' in the employ of the Corporation.

"Also, of the number of men employed in cleansing out the sewers, and of men employed at the outfall works at Saltley; and to report with reference to each of the above-mentioned classes what is the general condition of the health of the men so employed, and whether they suffer from diarrhœa, fevers, or any of the class of diseases generally attributed to cesspool and sewage emanations."

Appendix II.

Borough Surveyor's Report.

The average number of men engaged in getting out night soil is seventy-two; and there are, in addition to these, sixty men employed as carters, wharfmen, steerers, &c.

There are twelve men regularly employed in cleansing and flushing the sewers, and five in cleansing out gullies, and an average of twenty-eight men are engaged in removing the intercepted mud from the tanks at Saltley.

The Borough Surveyor further reports that several of these men have been in the employ of the Corporation for twenty years; that some of those in the night soil department were at work under Mr. Dester, and that, so far as he can ascertain, they do not suffer "from diarrhœa, fever, or any of the class of diseases generally attributed to cesspool and sewage emanations," and that their health is generally good.

APPENDIX III.

Correspondence with the Medical Department of the Privy Council.

APPENDIX III.

CORRESPONDENCE with the Medical Department of the Privy Council.

Church Road, Edgbaston,
August 10th, 1871.

SIR,—I take the liberty of addressing you under the following circumstances.

At the present time the Borough of Birmingham is surrounded with difficulties concerning the disposal of its sewage, two injunctions having been obtained, one of them restraining the authorities from sending it into the river, the other preventing the deposit from accumulating at the outlet of the sewers in such a manner as to become a nuisance.

The Town Council has appointed a Special Committee to consider the various aspects of the question, and to report their recommendations. Among other things the Committee will examine the present system of privies and open ashpits, so prevalent in this borough; the influence of such systems upon the public health, from exhalation and from soakage into the ground and wells; the large quantities of solid and liquid fœcal matters which drain into the sewers; and the general effect upon the sewage difficulty caused thereby; and similar collateral subjects.

A deputation has to-day returned from visiting several of the northern towns, for purposes of inquiry; and at Leeds was supplied with copious extracts from your recent report upon the sanitary condition of that town. I believe that in many particulars the state of the privies and ashpits in Birmingham is very similar to that of Leeds, and that an impartial and thorough investigation by the Medical Department of the Privy Council would be of inestimable value to the public health; and having read, with the greatest interest, your Leeds report, I am desirous of asking if you can undertake a like investigation as regards this borough.

Enclosed is a table of births and deaths, from which you will perceive the mortality is very high in some of the wards, though the death rate for the whole town is not excessive, as compared with other places. It must, however, be recollected that the local circumstances of Birmingham are unusually favourable.

Appendix III. —

I shall be glad to be favoured with your reply ; and permit me to add that the Town Council has instructed the Committee to present their report on the 26th of September next.

I remain, Sir,
Your obedient servant,

THOMAS AVERY.
(Chairman, Sewage Inquiry Committee.)

The Medical Officer of the Privy Council.

Medical Department of the Privy Council Office,
August 19th, 1871.

Sir,—I am directed by the Lords of Her Majesty's Privy Council to acknowledge the receipt of your letter of the 10th inst., and to inform you that their Lordships have been pleased to direct that an inspection of the sanitary state of Birmingham shall be made by one of the Inspectors of the Department, as soon as the state of business in the Department shall permit ; but that the inquiry will not include such questions of sewage disposal as are rather within the province of an engineer than of a medical inspector.

I am, Sir,

Your obedient servant

H. ROTTON.

Thos. Avery, Esq.,
Church Road, Edgbaston,
Birmingham.

APPENDIX IV.

Report of the Borough Surveyor on the Exclusion from the Sewers of Road Detritus, Old Water Courses, and Storm Water.

APPENDIX IV.

REPORT of the Borough Surveyor on the Exclusion from the Sewers of Road Detritus, Old Water Courses, and Storm Water.

TO THE SEWAGE INQUIRY COMMITTEE.

Sir and Gentlemen,—With reference to Minute 66 of the Committee :—

> 66. *Resolved*—"That the Borough Surveyor be instructed to report the approximate quantities daily discharged from the sewers at Saltley during dry and rainy weather, respectively distinguishing, as nearly as can be estimated, the relative proportions of sewage proper, and the contents of ancient streams and watercourses which have been diverted into the sewers; and that the Borough Surveyor be further instructed, with the view of diminishing as far as possible the volume of the sewage and bulk of the sedimentary deposit, to consider and report whether it would be practicable, at a reasonable cost, to separate, first, the surface and storm water, and, second, water from streams and watercourses aforesaid, and divert it into the river by the construction of some additional drains; and the direction, extent, and cost of such additional drains as the Borough Surveyor could recommend for that purpose. And that he be further requested to consider and report to this Committee the desirability and possibility of preventing the passage into the sewers of so much of the silt, and other products of the street sweepings, which now enter the sewers."

The BOROUGH SURVEYOR reports :—The borough contains 8,420 acres, of which 7,490 acres drain towards the river Tame, near Saltley, and the remainder, or 930 acres, towards the river Cole.

1,800 acres of land, having a natural drainage towards the Saltley outlet, and 750, acres having a natural drainage towards the river Cole, consist at present of agricultural lands.

There are about 183 miles of streets in the borough, estimated to cover about 1,000 acres, and there are also about 130 miles of sewers, constructed in accordance with the general system devised and adopted in the year 1845, besides several miles of old sewers.

The flow of the sewage at the Saltley outlet, during twenty-four hours of dry weather, on May 5th and 6th, was 16,518,224 gallons; the greatest flow was between 12 and 1 p.m. on the 5th, when 918,974

Appendix IV. —

gallons passed in the hour, and the smallest between 4 and 5 a.m., when 474,767 gallons passed in the hour; no doubt, some portion of this latter volume is subsoil water.

The volume of sewage discharged into the Cole during twenty-four hours of dry weather, as ascertained on Friday and Saturday, the 1st and 2nd instant, was 214,086 gallons.

The River Rea and Hockley Brook main sewers have each a sectional area of 1,720 feet; the ordinary dry weather flow of sewage occupies about one-fourth of such area.

There are thirty-three self-acting storm-water outlets in connection with the sewers, having a total sectional area of 198 feet. These are so arranged that, in case of heavy rain, the surplus water can pass into the Hockley Brook and River Rea.

The quantity of sewage discharged by the sewers in wet weather is determined by the amount of rainfall upon the borough in any given time, less the amount of such rainfall which may reach the river by means of the storm-water outlets, the quantity which may fall upon those portions of the borough not at present built upon, and that given off by evaporation. Assuming a rainfall of one inch in twenty-four hours, and the area of the borough which is occupied by buildings and streets, draining towards the Saltley outlet, at 5,690 acres, and that the whole of such rainfall would find its way into the sewers, the quantity would be about 129,000,000 gallons. The whole of this rainfall would not, however, be conveyed by the main sewers direct to the outlet. A large proportion would pass by means of the storm-water outlets into the River Rea or Hockley Brook. There would be much difficulty in estimating the quantity of water discharged, as much is re-evaporated from the surface in summer, and at no time will the whole flow off, but less in dry and hot summer weather than in winter.

With reference to the contents of ancient streams and water-courses, the Borough Surveyor is not aware of any instance where the water therefrom has been so diverted, unless the waters referred to were in so foul a state as to be a nuisance.

The water-sheds of several small streams which had their sources within the borough were, to a very great extent, covered with buildings long before the sewers were constructed, and the contents of privies, ash-pits, &c., were discharged into the courses of such streams, which in some instances had been covered over, and in others entirely lost; and the rainfall which made the streams before the erection of the buildings is now discharged direct therefrom into the sewers. Where the ground was not so covered with buildings they were mostly open stagnant ditches, and so great a nuisance that sewers had to be constructed to receive the sewage therefrom, as well as from the buildings in the neighbourhood thereof.

There are no records in the office of the contents of any of the streams. Their routes, as nearly as can be ascertained, are shown by a pink colour on the accompanying plan.

With reference to the practicability of separating the surface and the storm water, this could no doubt be effected by the construction of a duplicate system of sewerage and private drainage, which would have to be sufficiently capacious to convey the rainfall, not only from the surfaces of the streets, but from the roofs, yards, and premises, under all circumstances.

Should a separate system of sewers be adopted for the purpose of carrying off the rainfall, special provision would have to be made for flushing those used for conveying sewage only.

The Borough Surveyor cannot advise the construction of such duplicate system, but would recommend that the Council continue to avail themselves of every opportunity of getting rid of storm water by the construction of additional outlets, and for this purpose that the widening, deepening, and improving of the Hockley or Aston Brook and the river Rea (which would materially assist the work) should be proceeded with as early as practicable. To duplicate for water-closets, slaughter-houses, public establishments, and manufactories, would be a costly and inefficient work. Supposing such duplicate sewers and drains made and in work, the refuse must be dealt with at the outlets of the old and new sewers; the volume would not be diminished by dividing the quantity.

As to the desirability and possibility of preventing the passage into the sewers of mud, silt, and other products, the Borough Surveyor considers that the best way of effecting this would be by a systematic paving of yards, courts, footpaths, and carriage-ways; efforts may be made to intercept road drift before entering the sewers, but with our present macadamised roads, steep gradients, large area, and great traffic, it could not be done effectively, even at a very much greater cost than the present system.

Borough Surveyor's Office,
September 12th, 1871.

APPENDIX V.

Report of the Borough Surveyor on the Amount of Liquid Waste discharged into the Sewers from Certain Manufactories, in accordance with Resolution of Committee, No. 13.

APPENDIX V.

REPORT of the Borough Surveyor, showing the quantities of sewage discharged from brass-founders, galvanisers, manufacturing chemists, wire-drawers, and German silver manufacturers for six consecutive days:—

BERKELEY STREET. (Messrs. Tupper & Co, Galvanizers.)

	Gallons of Sewage entering Main—		
August, 1871.	7 a.m. to 7 p.m.	7 p.m. to 7 a.m.	Total in 24 hours.
" Tuesday, 15th	2,650 ...	— ...	—
" Wednesday, 16th	2,650 ...	4,110 ...	6,760
" "		12 midnight to 7 a.m., 1,930 gallons	
" Thursday, 17th,	2,850 ...	4,030 ...	6,880
" "		Heavy storm between 5 and 6 p.m.	
" Friday, 18th,	2,710 ...	3,360 ...	6,070
" Saturday, 19th,	2,650 ...	— ...	—
" Monday, 21st,	2,820 ...	2,790 ...	5,610

CHEAPSIDE. (Messrs. Breeden & Booth, Brassfounders.)

" Tuesday, 15th,	3,379 ...	— ...	—
" Wednesday, 16th,	3,220 ..	602 ...	3,822
" Thursday, 17th,	3,050 ...	400 ...	3,450
" "		Heavy storm between 5 and 6 p.m.	
" Friday, 18th,	3,610 ...	530 ..	4,140
" Saturday, 19th,	2,630 ...	— ...	—
" Monday, 21st,	3,100 ...	375 ...	3,475

CONSTITUTION HILL. (Messrs. Cartland, Brassfounders.)

" Tuesday, 15th,	640 ...	— ...	—
" Wednesday, 16th,	540 ...	260 ...	800
" Thursday, 17th,	730 ...	140 ...	870
" "		Heavy storm between 5 and 6 p.m.	
" Friday, 18th,	750 ...	210 ...	960
" Saturday, 19th,	720 ...	— ...	—
" Monday, 21st,	550 ...	230 ...	780

Appendix V.

GEORGE STREET. (Messrs. Vivian, German silver manufacturers.)

August, 1871.	Gallons of Sewage entering Main— 7 a.m. to 7 p.m.		7 p.m. to 7 a.m.		Total in 24 hours.
" Tuesday, 15th,	3,550	...	—	...	—
" Wednesday, 16th	3,550	...	390	...	3,940
" Thursday, 17th,	3,900	...	810	...	4,710
" "			Heavy storm between 5 and 6 p.m.		
" Friday, 18th,	3,710	...	590	...	4,300
" Saturday, 19th,	2,760	...	—	...	—
" Monday, 21st,	3,060	...	390	...	3,450

DARTMOUTH STREET. (Messrs. Armitage, manufacturing chemists.)

" Tuesday, 15th,	65	...	60	...	125
" Wednesday, 16th,	65	...	60	...	125
" Thursday, 17th,	110	...	200	...	310
" "			Heavy storm between 5 and 6 p.m.		
" Friday, 18th,	65	...	5,400	...	5,465
" Saturday, 19th,	3,470	...	—	...	—
" Monday, 21st,	3,600	...	3,080	...	6,680

DARTMOUTH STREET. (Messrs. Cornforth, Wire Drawers.)

" Friday, 18th,	4,560	...	50	...	4,610
" Tuesday, 22nd,	5,730	...	50	...	5,780
" Wednesday, 23rd,	5,130	...	50	...	5,180
" Thursday, 24th,	4,540	...	250	...	4,790
" "			Rain during most of the day		
" Friday, 25th,	4,570	..	40	...	4,610
" Saturday, 26th,	—	...	—	...	—
" "			7 a.m. to 12 a.m. 2,340 gallons		

Borough Surveyor's Office,
August 30th, 1871.

APPENDIX VI.

Accounts of the Sewage Farm at Saltley.

APPENDIX VI.

ACCOUNTS of the Sewage farm at Saltley.

With reference to Minute 65 of the Sewage Inquiry Committee —

65. "That the Public Works Committee be respectfully requested to furnish this Committee with an account of Income and Expenditure of the Sewage Farm, from its establishment to the end of the last financial year, distinguishing therein the prices realised for and the quantities of the different crops"—

The PUBLIC WORKS COMMITTEE report :—

That 35 A. 1 R. 25 P. of land at the Saltley outlet belong to the Council, of which about 14 acres are at the present time used for agricultural purposes; that in the year 1867, 109 acres of land were taken from W. Hutton, Esq., on a twenty-one years' lease at £7 per acre; 7½ acres from the Right Hon. Sir C. B. Adderley, M.P., for the same term, at £6 per acre; and 12 acres from the Incumbent of Water Orton Chapel, on a yearly tenancy of £50 per annum.

They append hereto Statement of Income and Expenditure on the Sewage Farm, and a return showing the prices realised for, and the quantities of the different crops.

There are at the present time about 47 acres of Italian rye grass, 41 acres of meadow grass, 17 acres of potatoes, and 4 acres of parsnips growing on the farm, besides about two tons of hay and the produce of 21 acres of oats.

Half-a-year's rent, amounting to £418 2s. 2d., will be due at Michaelmas next.

Borough Surveyor's Office,
Sept. 12th, 1871.

SEWAGE FARM.

A Statement of the Prices realised, and the Quantities of the different Crops produced, during the years ending Sept. 1868, 1869, 1870, and 1871.

Date.	Rye Grass.		Hay.		After-math, &c.	Ley for Cattle.	Oats.	Wheat and Barley.		Straw.		Potatoes.	Sundry Vegetables.	Totals.
	T. C. Q.	£. s. d.	T. C. Q.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	bags	£. s. d.	T. C. Q.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Sept. 1, 1868	308 10 0 varying in price from 10s. to 18s. per ton.	215 13 6	...	...	48 0 0	356 14 11	50 0 0		25 12 6 Barley.					696 0 11
Sept. 1, 1869	711 0 0 varying in price from 10s. to 14s. per ton.	468 6 4	...	...	...	257 0 6	...	...	...	...	...	..	Mangolds. 10 0 11 Turnips. 2 10 0 Cabbages. 1 7 6 13 18 5	739 5 3
Sept. 1, 1870	469 10 0 at 14s. per ton	328 13 0	22 14 2	107 18 10	25 0 0	159 10 0	...	34	27 16 0 Wheat.	7 1 1	21 3 10	10 6 4	Vetches. 9 1 3 Cabbages. 10 5 10 19 7 1	699 15 1
Sept. 1, 1871	524 17 3 varying in price from 14s. to 20s. per ton.	613 16 10	14 12 1	73 2 0	...	226 0 5	147 0 0	73	67 4 6 Wheat.	27 13 2	96 17 3	92 15 9	Cabbages. 9 1 7 Swedes. 15 18 9 Parsnips. 85 2 1 110 2 5	1426 19 2
...	...	1626 9 8	...	181 0 10	73 0 0	999 5 10	197 0 0	...	120 13 0	...	118 1 1	103 2 1	143 7 11	3562 0 5

Borough Surveyor's Office,
September 12th, 1871.

CURRENT ACCOUNT.

Statement of Receipts and Payments on account of the Sewage Farm from September 1st, 1867, to September 1st, 1871.

RECEIPTS.		PAYMENTS.							
For year ending	Sale of Grass, Cattle, Ley, &c.	For year ending	Rent and Taxes.	Wages.	Implements and Materials.	Seeds.	Team Hire.	Interest on Loan and Deposit to Sinking Fund.	Total.
	£. s. d.		£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Sept. 1, 1868	696 0 11	Sept. 1, 1868	415 1 3	156 15 6	30 15 6	69 4 7	...	...	671 16 10
" 1869	739 5 3	" 1869	969 15 9	287 19 9	...	53 19 2	...	162 10 0	1474 4 8
" 1870	699 15 1	" 1870	929 4 7	672 0 0	23 11 11	102 12 4	89 16 9	363 13 8	2180 19 3
" 1871	1426 19 2	" 1871	977 17 2	713 0 0	24 14 3	136 15 11	402 9 2	446 5 0	2701 1 6
Total ...	3562 0 5	Total ...	3291 18 9	1829 15 3	79 1 8	362 12 0	492 5 11	972 8 8	7028 2 3

Borough Surveyor's Office,
September 12th, 1871.

REPORT OF THE BOROUGH TREASURER.

BOROUGH OF BIRMINGHAM.—Statement of Receipts and Payments on Account of Utilisation of Sewage, from 1st September, 1867, to 31st August, 1871, inclusive.

REVENUE ACCOUNT.

RECEIPTS.

	Sale of Grass and Rent of Meadow Lands.
For year ending 31st August, 1868	£696 0 11
" " " " " 1869	739 5 3
" " " " " 1870	699 15 1
" " " " " 1871	1,392 11 7
	£3,527 12 10
Balance, being Payments over and above Receipts, to 31st August, 1871, inclusive of Payments on Capital Account	9,728 18 9
	£13,256 11 7

PAYMENTS.

	Rent and Taxes.	Wages.	Implements and Materials.	Seeds, &c.	Law and Professional Charges, &c.	Miscellaneous.	Interest on Loan and Deposit to Sinking Fund.	Total Payments.	
	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	
For year ending 31st Aug., 1868...	415 1 3	2,504 0 0	382 1 9	69 4 7	223 3 8	339 18 3	...	3,933 9 6	*a*
" " " " 1869...	969 15 9	1,404 0 0	269 8 0	53 19 2	...	505 7 3	162 10 0	3,365 0 2	*b*
" " " " 1870...	929 4 7	752 0 0	51 9 1	102 12 4	308 17 10	156 9 3	363 13 8	2,664 6 9	*c*
" " " " 1871...	977 17 2	713 0 0	24 14 3	136 15 11	564 1 2	431 1 8	446 5 0	3,293 15 2	
	3,291 18 9	5,373 0 0	727 13 1	362 12 0	1,096 2 8	1,432 16 5	972 8 8	13,256 11 7	

REPORT OF THE BOROUGH TREASURER—*Continued.* Appendix VI.

CAPITAL ACCOUNT AND SINKING FUND.

a	*Less* transferred to Capital Account in 1868 ...	£3,250	0 0
b	„ „ „ 1869 ...	1,890	10 7
c	„ „ „ 1870 ...	495	5 1
		£5,635	15 8
	Loan negociated 3rd December, 1869, pursuant to Council Minute, No. 6,805	5,000	0 0
	Capital Account overdrawn, as per Treasurer's Blue Book for 1870, page 80	£635	15 8
	Loan negociated as above, to be paid in 20 years...	£5,000	0 0
	Less Sinking Fund in hand, 31st December, 1870...	412	10 0
		£4,587	10 0
	Add Capital Account, overdrawn as above ...	635	15 8
	Balance remaining, to be provided for as per Treasurer's Blue Book for 1870, page 89	£5,223	5 8
	Less Deposit to Sinking Fund 31st August, 1871...	250	0 0
	Balance remaining, to be provided for 31st August, 1871	£4,973	5 8

APPENDIX VII.

Extract from Manchester Local Government Act, and Specification of Manchester Privy.

APPENDIX VII.

EXTRACT from the Manchester Local Government Act, and and Specification of Manchester Privy.

COPY CLAUSES 65, 66, 67, 68, and 69, of "An Act for the Good Government and Police Regulation of the Borough of Manchester." Cap. 40 (4th July, 1844).

65. And be it enacted, That the owner of every house to which no sufficient privy or ashpit is attached, shall provide such fit and proper privy to the same, in such situation, and with such proper door and covering to such privy, and also such fit and sufficient ashpit, and in such situation, as the Council shall consider requisite for the use of the inmates or occupiers thereof; provided that a privy and ashpit, or two or more privies and ashpits, may, with the approbation of the Council, be used in common by the inmates and occupiers of two or more such houses.

66. And be it enacted, That no house shall hereafter be built without there being constructed, to the satisfaction of the Council, either in such house, or in a yard attached to such house, a privy, with proper doors and coverings to the same, and also an ashpit, together (if required by the Council) with a proper funnel or flue, or other means for carrying off upwards any offensive stench from such privy and ashpit: provided that, in the case of houses in courts, a privy and ashpit, or two or more privies and ashpits, may, with the approbation of the Council, be used in common by the inmates and occupiers of such houses.

67. And be it enacted, That no warehouse, manufactory, or workshop shall hereafter be built without there being constructed, to the satisfaction of the Council, either in such warehouse, manufactory, or workshop, or any yard attached thereto, a privy, with proper doors and coverings to the same, and together, if required by the Council, with a proper funnel or flue for carrying off upwards any stench arising from such privy.

68. And be it enacted, That the owner of every house, warehouse, manufactory, or workshop now built, or hereafter to be built, shall keep the privy and ashpit belonging to such house, warehouse, manufactory, or workshop, or used by the inmates or occupiers thereof, or persons employed therein, in good repair to the satisfaction of the Council, and in the case of a privy used in common by the inmates of several houses, shall keep such privy well and sufficiently cleansed and emptied; and if the owner of any house, warehouse, manufactory, or workshop shall not

Appendix VII — provide the same with a privy, with such door and covering to the same, or with such ashpit as aforesaid, or shall not repair the said privy and ashpit, or cause any privy used by the inmates of several houses to be well and sufficiently cleansed and emptied, to the satisfaction of the Council, within one month next after notice in writing for that purpose from the Council, signed by the Town Clerk, shall have been given to such owner, or left for him at his usual or last known place of abode in England, or upon or affixed to the premises in respect of which the same shall be given, every such owner making default shall for every such default forfeit any sum not exceeding Five Pounds, and any further sum not exceeding Ten Shillings, for every week during which such default shall in anywise continue unamended: provided that the Council may, after giving reasonable notice to the owner or occupier of any house, warehouse, manufactory, or workshop, order the privy or ashpit belonging thereto to be cleansed and emptied, and charge and recover the expense thereof from such owner or occupier in like manner as any penalty imposed by this Act.

69. And be it enacted, that after the First day of October next, after the commencement of this Act, no person shall be employed in cleansing or supplying any privy or ashpit, or in collecting or removing dirt, ashes, or rubbish, within the borough, unless such person shall have been appointed by the Countil, or shall have obtained a licence from the Council for that purpose, and every person so offending, or who shall knowingly employ for any such purpose any person not so appointed by the Council or licensed as aforesaid, shall forfeit a sum not exceeding Five Pounds, to be recovered as any penalty imposed by this Act is recoverable.

SPECIFICATION

Of Work required by the Health Committee of the Council of the City of Manchester, to be executed by Mr. .... at ..... Property, situate ..... in the Township of.....

The present privies and ashpits must be entirely pulled down, and reconstructed in accordance with the accompanying plans.

The foul earth under the old ashpits and privies must be excavated to a depth of eighteen inches, and at once carted away from the works.

The old ashpits must be filled in where required with suitable dry, hard material, small, and well rammed in level courses not exceeding six inches in thickness.

The several walls are to be built to the forms and dimensions shown on the drawings.

The floors of the ashpits are to be of glazed earthenware, and laid with an inclination of not less than nine inches from the sills of the emptying doors towards the backs of the privies, and the flange of the floor at the shallow end of the ashpits must be fixed flush with the door sill and built in as the work proceeds.

If the privies be against the wall of a dwelling house, such wall must be lined with a Rochdale flag, three inches in thickness, up to the underside of the lintels carrying the division walls of the privies.

The floors of the privies are to be flagged and laid with an inclination of not less than half-an-inch to the foot towards the doors and raised twelve inches from the level of the yards.

The privies are to be so constructed as to ensure the ashes being deposited upon the night soil.

The lintels carrying 4½ inches division walls, between the flues and the privies, must not be set lower than two inches below the top side of the privy seats.

The seats must be hinged with strong wrought-iron bands and gudgeons, the gudgeons being driven into the lintels which carry the 4½ back walls. Each seat is to have a hinged fall.

The doors to the privies must be 1¼ inch thick ledged doors, pierced with at east four 1¾ inch holes at the top, and hung to frames 4½ × 3 inches with strong wrought-iron bands and gudgeons, and fastened with locks and keys of a pattern to be approved by the City Surveyor.

The emptying holes of the ashpits must be two feet square (inside the frames), and have ledged doors 1¼ inch thick, hung to frames 4½ × 3 inches, with strong wrought-iron bands and gudgeons, and fastened with locks and keys, and built in with the brickwork, the top side of the sill to be fixed three inches above the adjoining passage.*

The ashpits must have ventilating flues constructed of brickwork, metal, or earthenware pipes; the size of the flue to be (if square) 9 × 9 inches, (if of circular earthenware pipes) 6 inches diameter, and carried three feet above the eaves of the house, and secured to the walls with strong bands and clips.

The privies and ashpits must be covered in either with slated or flagged roofs, well pointed with lime-and-hair mortar.

The privies must be twice limewashed.

All the woodwork, with the exception of the privy seats, must have two coats of good-bodied oil paint.

The yards must each have a trap and grid, placed in such a position in the yard that the waste pipe from the slop-stone shall discharge itself on the grid.

All flagging and every other thing necessary must be made good.

Patterns of locks and keys, bands and gudgeons, and grid and trap, may be seen at this office, and none other will be allowed.

The whole of the works shall be executed to the entire satisfaction of the City Surveyor, and will not be deemed finished or complete until they have been certified to be so in writing by him.

Written notice must be given at this office three days before the work is commenced, without which no certificate of completion will be given.

J. G. LYNELL, City Surveyor.

Surveyor's Office, York Chambers,
King Street.

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* Iron doors are now used instead of wood; cost, 10/6, instead of 8/6.

APPENDIX VIII.

Report from Mr. W. Sharp, Master of the Birmingham Work-house, on Collection of Excrementitious Matters.

APPENDIX VIII.

Report from Mr. W. Sharp, Master of the Birmingham Workhouse, on Collection of Excrementitious Matters.

Birmingham Workhouse,
7th September, 1871.

Sir,—In response to resolution of the Sewage Inquiry Committee, I beg respectfully to state that since 23rd June last, when I wrote to Mr. Alderman Avery, enclosing a scheme for the collection of excrementitious matter, both solid and liquid, I have had further opportunity for considering the subject, both by additional experiment myself, and by viewing, in company with a deputation of the Inquiry Committee, the system of collection and deodorising in practice largely at Rochdale; and I am more than ever convinced as to the feasibility and desirability of carrying into operation in this borough the plan I ventured to suggest. Instead, however, of removing twice weekly, I am satisfied that a weekly removal will be sufficient. This alteration will so materially reduce the cost of collection that, in my opinion, the staff and outlay which I considered would be necessary for collecting the fœcal matter, will be sufficient—in addition to doing this work—to remove all ashes and refuse usually to be found in ashpits, if tubs or other suitable receptacles are provided for the collection; the ashes, &c., to be taken to depôts, and used for deodorising the excrementitious collections, and otherwise dealt with as at Rochdale.

In company with Mr. Woolley, I some time ago examined the privies in Park Street and in John Street, and saw none to which the suggested system could not be applied with very great advantage, both in a sanitary and economical point of view.

The system of collection at Rochdale, the existence of which I was entirely ignorant of when I sent in my scheme, is so exactly what I had thought should be adopted, that I feel it will be needless for me to enter into any further details, because the deputation having made itself thoroughly well acquainted with the system of collection and deodorising as there practised, will be able to speak with a full knowledge of the matter, either in favour of the system or against it.

Faithfully yours,

William Sharp.

E. J. Hayes, Esq., Town Clerk, Birmingham.

APPENDIX IX.

Questions addressed by the Committee to the Mayors, or other Authorities, of Towns where the System of Sewage Irrigation has been adopted; and replies received thereto.

APPENDIX IX.

QUESTIONS addressed by the Committee to the Mayors, or other Authorities, of Towns where the System of Sewage Irrigation has been adopted; and Replies received thereto.

QUERIES ON BEHALF OF THE CORPORATION OF BIRMINGHAM.

1. What is the population of your town, or the district which produces the sewage?
2. What is the number of water-closets in the same district; and do the cess-pools, or any of them, communicate with the sewers? If so, can you give the number of such communications?
3. What is the average daily flow of the sewage?
4. Can you furnish any analyses of the sewage?
5. How many acres of land are under irrigation, and how long has the system been in operation?
6. What distance is the land from the town?
7. What is the nature of the land and subsoil?
8. What is the general contour of the land?
9. Was the land purchased, or is it rented? and what was the purchase-money per acre, or what is the rent?
10. Is the land in the hands of the authorities, or do they let it, and, if so, on what terms?
11. What was the cost of conveying the sewage to the land?
12. Is the sewage raised to a higher level, if so, to what height is it raised, and the cost of so pumping it?
13. What was the cost of preparing the land for irrigation, per acre?
14. What system of distribution is adopted?
15. Are the the main channels, for distributing the sewage over the land, covered?
16. Is the land drained, and to what depth?
17. What is the average number of acres daily under irrigation?
18. How many acres are under Italian rye grass?
19. How many cuttings of this grass are obtained during the year?
20. How many times is the land under rye grass irrigated between each cutting; and what is the duration of, and the quantity of sewage per acre used in, each irrigation?

Appendix IX.

21. After what time is the land under rye grass ploughed up; and is the land so ploughed up re-sown with rye grass, or put under other crops?
22. What other crops are grown, and the number of acres of each Are they all irrigated?
23. What is the duration of, and the quantity of sewage per acre used in, each irrigation of each of these crops?
24. Has the produce of any of these crops been unsatisfactory?
25. Is any land left fallow; if so, is this land irrigated, and how often?
26. What portions of the land are irrigated during the winter?
27. Have any difficulties occurred in disposing of the sewage at any season?
28. What becomes of the storm water?
29. Can you furnish a balance-sheet of each year, showing cost of cultivation, &c., and the prices realised for each crop?
30. Have any complaints been made of any nuisances alleged to have been caused by the irrigation? and, if so, how have you dealt with them?
31. Have the wells of the district been affected?
32. Is it supposed that the health of the district has been in any way affected by the system?
33. Is the state of the effluent water satisfactory, and can you furnish analyses of it?
34. Is there a ready market for the rye grass, and have there been any complaints as to the cattle fed on it not thriving?
35. Are any and what cattle fed on the land irrigated, and do these cattle thrive?
36. Have any cattle fed on your sewage-grown grasses been found to be affected with entozoa?
37. Does the land generally appear to improve under irrigation?
38. Does any of the land appear to have suffered from too much irrigation? if so, what are the crops affected?
39. If you grow potatoes, do they appear to suffer more than usual from disease?
40. Has this present wet season in any way interfered with the system?
41. Did the frost of last winter prevent, or seriously interfere with, irrigation?
42. Has it been found necessary to use other, and, if so, what manures besides sewage for any of the crops? and what are those crops?
43. Are there any other matters to which no reference has been made above, which you consider of importance as affecting the question of the adoption of the system? If so, have the goodness to state them.
44. If you have any Report or printed document explanatory of your system, will you have the kindness to supply a copy of it?

REPLIES FROM BANBURY.

1. Nearly 12,000; about 500 of these do not contribute to the sewage.
2. About 2000. Scarcely any cess-pools exist.
3. 300,000 gallons (exclusive of rainfall) in 24 hours.
4. *Vide* Report of Rivers Commission.
5. 130 acres. This is the fourth season.
6. About one mile.
7. Stiff and tenacious, with clay subsoil.
8. The farm is in a valley; it is about a mile through it, and a fall of about 20 feet.
9. Rent £4. 10s. per acre.
10. The Board of Health occupy the land.
11. £5,000 was spent in carrying out the scheme.
12. Yes; to a height of 21 feet.
14. Gutter and pane, and ridge and furrow.
15. No.
16. Yes; about three feet.
17. Four or five.
18. About 30.
19. Four or five.
20. Once. About four days.

21 and 22. Three or four years. Roots after rye grass, then oats and rye grass sown together. These crops are irrigated with the exception of swedes and oats. Cabbages are also grown, but the land is not irrigated during growth.

23. Ground thoroughly soaked.
24. No.
25. Not left fallow.
26. Principally the natural grass land.
27. No.
28. Runs into the river.
30. No.
31. No.
32. No.
33. *Vide* Report of Rivers Commission.
34. Ready sale. No; cattle thrive remarkably well.
35. Horses, bullocks, and milking cows have done well. They had no water to drink except the effluent water from the land.
36. Certainly not.
37. Very much.
38. No.
39. No potatoes have been grown.
40. No.
41. No.
42. None.

REPLIES FROM BEDFORD.

1. 16,800.
2. 3,300 water-closets; no cess-pools drained into sewer.
3. About 600,000 gallons.
4. Analyses of sewage and effluent water as given by R.P.C. Report enclosed.
5. About 130 acres.

Appendix IX. — Bedford.

6. About 1,000 yards to nearest part; some of it much more.
7. Deep soil, with gravelly subsoil.
8. Nearly level.
9. A portion belonged to the Corporation; the remainder is rented at from £5 to £6 per annum.
10. In the hands of the Corporation.
11. The sewage is conveyed from the tank to two parts of the land in cast-iron pipes, and cost £878.
12. Pumped 25 feet. Cost per annum about £300.
13. About £15 per acre.
14. The greater part ridge-and-furrow system, the remainder on the catch-water system.
15. The main carriers are stoneware pipes; distributing channels are principably formed of half-round glazed stoneware tiles.
16. There is only one drain laid; the subsoil drains into the adjoining ditches and water-courses.
17. About 20 acres.
18. 40 acres.
19. From 5 to 6 cuttings.
20. It is irrigated about 20 days between the cuttings.
21. After two years it is ploughed up and sown with other crops.
22. Such as roots, cabbages, &c. They are all irrigated.
24. No.
25. It is not left fallow long; it is, however, irrigated.
26. The rye grass and fallows.
27. Yes, a little in wet weather.
28. The surface water from streets and roads is taken by old drains into river, so that the sewers are not much affected by heavy rains. A storm-water overflow is laid into the river, but not often comes into use.
29. No; but one is being prepared.
30. No.
31. No.
32. No.
33. Yes. Analyses enclosed.
34. The sale is middling good. There are no complaints.
35. There are no cattle fed on the land; our own horses eat the grass, and do well.
36. No.
37. Yes.
38. No.
39. No; this year they are perhaps better than usual.
40. A little dry weather is best.
41. Not seriously.
42. No.
43. No. I think your questions pretty much to the point.
44. We have none, or I would send you.

Bury St. Edmunds.

REPLIES FROM BURY ST. EDMUNDS.

1. About 15,000.
2. The number of water-closets I cannot state with any accuracy—perhaps 300. Private cess-pool or dead well on premises emptying into sewers, probably 200.

3. About 150,000 gallons.
4. No.
5. 26 acres. Six years next Michaelmas.
6. About a mile and quarter from centre of town.
7. Light, with gravelly subsoil.
8. A somewhat steep side hill.
9. The land is leased for 21 years, at £4 per acre; worth, intrinsically, about 25s. per acre.
10. The Board held the land for the first three years, and then let it to a neighbouring farmer at £150 a-year, the farmer paying all expenses for labour on the land, the Board pumping the sewage.
11. Cannot now say.
12. The sewage is pumped to a tank situated on the highest part of the irrigated ground, about 50 feet above pumps. Cannot now say cost.
13. Most of the land was under the plough when we took it. The cost in our case is not a general guide.
14. The catch-water or gutter system.
15. No.
16. No.
17. About an acre.
18. All, when in the hands of the Board. The present occupier is growing some corn, probably at a considerable loss.
19. Five.
20. Twice. Cannot answer at this time the latter question.
21. The grass will stand three years here, after which it is desirable to plough it up, and re-sow with Italian rye grass; but in some cases and on some lands it may be desirable to have other crops.
22. The land intended for corn root crops is usually well irrigated previously to the crop being sown, but not during growth.
23. Cannot now say.
24. As regards grass crops, the produce has been in proportion to the quantity of sewage employed. Corn crops are much laid, especially in a wet season.
25. We have never left any land in fallow.
26. All parts.
27. No.
28. It is absorbed in the land in our case.
29. No.
30. Complaints are occasionally made (there are a few houses within two furlongs of our ground), and perhaps with some reason; but a little care and cost would obviate them. I have found very little smell while the sewage is fresh; but if allowed to stand in the tanks and ferment, a considerable amount of impure gases is given off. In such cases, and in hot weather, I use some carbolic acid. Irrigation tanks and grounds are not supposed to represent drawing-rooms.
31. No; but there are none here to be affected.
32. No.
33. All the sewage is absorbed by the land. Cannot furnish analyses.
34. At first we had a difficulty in disposing of the grass; but now there is a fair demand. The cattle are very fond of it.
35. No cattle are allowed to be fed on the land irrigated; they spoil the gutters.
36. I am not aware. Have not heard of a case.

Appendix IX. — Bury St. Edmunds.

37. Yes, very much.
38. With care, nothing of the sort occurs here; but if the sewage is allowed to run over in considerable quantities at one place, the grass at that place is injured. Considerable care is required in levelling the gutters and in dispersing the sewage.
39. I have had no experience with potatoes.
40. No; our land being light, the wet season has been favourable; some wheat and oats are very luxuriant, wheat 10 to 12 coombs per acre; oats about 20 ditto. Last year very moderate.
41. No; we have a considerable quantity of warm water running into the sewage, which I consider beneficial.
42. Our soil would probably absorb almost any quantity of manure; but I have found the sewage ample to produce excellent crops of grass. We have applied sewage only.
43. Moderately stiff land should be selected, and let sewage flow on by gravitation, if possible.
44. We have no report.

Carlisle.

REPLIES FROM CARLISLE.

1. 31,080.
2. The number of water-closets in use is about 1,900. No cess-pools.
4. No.
5. About 110 acres. Since 1860.
6. Within the municipal boundary.
7. Alluvial soil on gravel.
8. Flat, with a very slight fall.
9. Rented by Mr. McDougall from the Corporation and the Duke of Devonshire, at about £4 per acre.
10. See No. 9.
11. The main outfall sewer runs through the land.
12. Pumped to a height of about 12 feet, but as the works are in private hands the cost cannot be given.
14. By open iron carriers.
15. No.
16. No; it is not required, being of a very porous nature.
18. None.
22. The land is all in permanent pasture and is grazed by cattle, horses, and sheep.
26. All of it in succession.
27. No.
28. It runs into the river Eden.
29. No.
30. None.
31. Not by the irrigation works.
32. No.
33. There is none, as the sewage all percolates through the soil.
34. See No. 22. The cattle thrive.
35. See No. 22.
36. Nothing of the kind has been reported.
37. Yes, *very much.*
38. No.

40. No.
41. No.
42. No.
44. None.

REPLIES FROM CHELTENHAM.

1. About 40,000.
2. Water-closets are pretty general, but the cottages in many cases have the closets only panned and trapped, having no regular supply. Cannot state number of these instances.
3. About one or one and a quarter million gallons.
4. No.
5. 130 acres of our own and nearly 200 acres of adjacent owners.
6. About two miles.
7. Our own land is clayey, and so is the greater proportion of that adjacent.
8. It has a gentle current towards the streams which drain the district.
9. It was purchased at £80 an acre, including timber.
10. The Commissioners let it chiefly by the year, by auction, and keep some men to attend regularly to the irrigation.
11. The outfall sewers from the tanks cost from £6,000 to £7,000.
12. It flows by gravitation.
13. Probably about £4 or £5 an acre.

15—16. It flows over the land in open carriers, and the land is drained generally, but not very deeply.

17. Probably about ten or twelve acres.

18, &c. We have only a very limited quantity of Italian rye grass sown—say six acres—and cannot state results at present, the main quantity of sewage being applied to old pasture land, after the solid portions have been filtered and deposited at the tanks.

24. The produce of the grass crops has been most satisfactory.
25. None left fallow.
26. During winter it is generally passed over our own land.
27. No.
28. A great portion passes into the streams.
29. No. But we get more than £7 per acre rent for land worth about half that sum previously; also a small yearly rent (15/- an acre) for irrigation of adjacent land, and the deficiency, after paying interest and yearly repayments on purchase of land and permanent works, is almost nominal.
30. No well-founded complaints have been made; three only altogether, and these could not be substantiated.
31. No; means have been taken to prevent this.
32. No.
33. Yes; but I cannot furnish any analyses.
34. We have had but little rye grass for sale.
35. Cattle thrive on land most satisfactorily; milking cows, stock, horses and sheep all do well.
36. Not a single instance.
37. Yes, most decidedly.
38. No.
39. We grow none.

Appendix IX. — Cheltenham.

40. No; beyond the difficulty of making hay during the previous rainy weather.
41. No. See the Report of British Association Committee (published by Macmillan).
42. No.
43. I think not. The results of the system at Cheltenham have been very satisfactory.
44. No formal report printed.

Edinburgh.

REPLIES FROM CORPORATION OF EDINBURGH,

with reference to the district draining by *Craigentinny Meadows.*

1. 96,000.
2, 3, 4. Cannot state the number of water-closets, &c. From this district there flows about 20 cubic feet of spring water per minute, the surplus rainfall being the non-absorbed portion of 24 inches per annum, and the sewage from a population of 95,589 persons, according to the census of 1861, with a water supply of 25 gallons per head. Of this population about 60,000 have the use of water-closets; and the excrementitious matter from about 15,000 or 20,000 of the remainder finds its way to the sewers connected with the burn.
5. 250 acres. Since about the year 1748. Sward Meadows have existed since 1561.
6. Half a mile, fully.
7. Various kinds of soil and subsoil: forced earth over sand, peaty ground, sandy clay, loamy clay, sea sand.
8. A wide valley stretching out to a plain.
9. The land does not belong to the Corporation.
10. See above.
11. It flows by gravitation in an old water-course.
12. A small part is irrigated by pumping, the motive power being the sewage.
13. Cannot now be stated. Some of it near the sea cost £23. 6s. 8d. per acre.
14. Gutters and panes.
15. No.
16. To a depth of four feet.
17. Depends upon the season.
18. About 40 acres.
19. 4, 5, or 6.
20. Twice for twenty-four hours, and a dressing enough to soak the grass roots. The quantity has not been measured; it is practically unlimited.
21. Once in two years. Meadow grass is also grown, which has not been re-sown for forty years.
22, 23, 24. No other crops.
25. No fallow.
26. Sandy soil near sea only.
27, 28. No. It flows to Firth of Forth.
29. No.

30. Complaints made about thirty years ago. None recently.
31. No.
32. Some people think so.
33. The effluent water is purer than sewage, but not quite pure. No analysis.
34. Ready market. The land is let to cowkeepers, who cut and remove the grass as wanted.
35. Cows only.
36. No knowledge of the cows eating the grass being affected by it.
37. Yes.
38. No.
39. Do not grow potatoes.
40. No.
41. No.
42. No manures.
43. It will be necessary to consider local circumstances as affecting the question.
44. The borough engineer wrote a paper on the subject. It is out of print, but largely quoted in the report of the Tottenham Local Board of Health, May, 1870, published by E. and F. N. Spon, 48, Charing Cross, London.

REPLIES FROM WARWICK.

1. 11,001.
2. Nearly 2,400 water-closets.
3. 528,000 imperial gallons.
4. Yes, as supplied by the Rivers Pollution Commissioners in their 1870 Report.
5. 135 acres; three and a half years nearly.
6. One mile and a half.
7. Stiff clay.
8. Undulating.
9. Lease for 21 years, expiring 1887; £420 10s. average rental per annum.
10. Farmed for the Corporation by the undersigned as manager.
11. £10,084. 18s. 1d.; this includes extension of sewers, pumping engines, &c., &c.
12. Pumped 65 feet, at annual cost of about £600, not including interest of money.
13. From £1. to £10. per acre, according to nature of ground.
14. Ridge-and-furrow and catch-work systems.
15. Not all covered.
16. At the present it is only partially drained, but it is my intention to thoroughly drain at a depth of about three feet.
17. Ten to fifteen.
18. 60 acres.
19. Four to six cuttings, according to quality of crop.
20. Depends upon the season and fertility of the soil; in the summer months three to six dressings between each cutting, one month interval.
21. Two to five years; in ordinary cultivation should not exceed two years.

Appendix IX. — Warwick.

22. Wheat, oats, potatoes, carrots, parsnips, mangolds, swedes, turnips, beet, cabbage, celery, hay, &c., &c. All are irrigated, varying from 1,000 to 10,000 tons per acre per annum.
23. The variation is considerable.
24. None.
25. Yes; irrigated off and on during the whole winter for root crops.
26. The entire farm.
27. Seldom, if any.
28. A great portion passes by duplicate sewers to the river.
29. Yes.
30. Slightly at first, in consequence of prejudice; but no complaints at present time.
31. The well water at the farmhouse is excellent.
32. I have not heard.
33. Yes.
34. Yes, to the first question; and no, to the last question.
35. Horses, cows, and sheep have been fed on the land, and have thriven.
36. None.
37. Yes.
38. Yes, where drainage does not exist; all crops (paying) are affected from want of air to the roots.
39. Potatoes grown by sewage irrigation good when compared with others grown on same land in usual manner this year.
40. Only in disposal of produce and making of hay.
41. No.
42. Only experimentally has top dressing been used.
44. My last report was forwarded to his Worship the Mayor; my next shall be forwarded as early as possible. Any further information shall be freely given upon application.

EDWARD PRITCHARD, Aux. I.C.E.,
Borough Surveyor.

Warwick, 9th September, 1871.

Wolverhampton.

REPLIES FROM WOLVERHAMPTON.

1. 68,237 (census 1871).
2. Not known, probably 500. No cess-pools communicate with the new sewers, possibly some do with the old sewers and drains.
3. Dry weather sewage about 2,500,000 gallons.
4. No.
5. 20 acres since Michaelmas, 1870; and 30 acres since Lady-day, 1871.
6. 2½ miles (from the centre of the town).
7. A portion loamy clay and sand; and a portion peat and light soil.
8. A portion has an average inclination of 1 in 20, and a portion has an average inclination of 1 in 200.
9. The land was purchased, and cost about £106 per acre.
10. The farm, which contains 283 acres, is let for seven years at a rent of £750 per annum, subject to an increased rent for such portion of it as may be benefited by the sewage.
11. About £1,450.
12. No.
13. About £10 per acre.
14. Open carriers and catch-water drains.

15. The main carrier is open except a portion near the farm house and buildings, which is constructed under ground.
16. There are some old drains through the land, about 3 feet deep; at present they are sufficient.
17. About five.
18. 28 acres.
19. Three, up to the present.
20. No return.
21. It has not been ploughed since it was laid down.
25. No.
26. About 20 acres.
27. No.
28. Some passes into the natural channels.
29. No.
30. None from the process of irrigation; one from the sewage being allowed to flow into a tributary of the river Pink, through carelessness.
31. No.
32. No.
33. Yes; no.
34. Yes; no.
35. Sheep and cows have been fed on a portion of old grass land, not on the rye grass.
36. No.
37. Yes, decidedly.
38. No.
40. No, except the present quantity of land is not sufficient.
41. No.
42. No.
43. *Extract from a Letter sent with these replies.*—"A complete system of sewers is being carried out, which will not be finished for about two years. It is intended to utilise the sewage by irrigating lands lying to the north-west of the town, in which direction there are about 1,000 acres, within a maximum distance of three miles from the centre of the town, available for irrigation by gravitation. The Corporation have purchased 283 acres to commence with, on which a portion of the sewage is being used, and they are negotiating for additional land.

APPENDIX X.

Offers received by the Committee to deal with the Sewage of the Borough from:—

The A B C Company.

The Peat, Engineering, and Sewage Filtration Company.

The Phosphate Sewage Company.

APPENDIX X.

OFFERS received by the Committee to deal with the Sewage of the Borough from :—

The A B C Company.

The Peat, Engineering, and Sewage Filtration Company.

The Phosphate Sewage Company.

1, St. Swithin's Lane, London,
15th Sept., 1871.

Thomas Avery, Esq.,
Chairman of the Sewage Committee,
Birmingham.

Sir,—The Board of the Native Guano Company having heard that your Committee will soon have to make their report to the Council as to the best mode of utilising the sewage of Birmingham, have resolved to make a positive offer which may accompany that report.

Feeling confident that the sewage of Birmingham can be treated by the "A. B. C." process, so as to remove all sanitary complaints and to leave satisfactory commercial results, my Board are willing to propose for your Committee's consideration similar terms to those arranged with the town authorities of Leeds, and that the following shall be the basis of arrangement :—

1. That the town grant this Company (or a branch company, if such is found desirable) a concession of the sewage of Birmingham for thirty years.

2. That the town erect the necessary works, and find the land required, according to plans approved by the Company. The estimate for the outlay is £50,000.

3. That the works shall be completed within nine months.

4. That this Company agree to take charge of the works when completed, and to carry on their process there, paying to the town, out of profits, a rent of 5 per cent. on the outlay incurred, and 15 per cent. of the net profits.

5. That the works become the property of the town at the expiry of the lease.

[illegible]

[illegible]

[illegible]

dimensions. In support of the feasibility of this plan, I may mention that right in the very heart of this town of Liverpool I know one sugar refinery where the re-carbonising process is carried on to the extent of about 600 tons per week, and the whole work is done upon a very small area indeed.

All the calculations which I have here given must be considered as nothing more than rough approximations, but they are sufficiently close to show that the difficulty you raise is by no means so formidable as at first sight appears.

In order, however, that you may have a sound and unquestionable basis to go upon, I may venture to say, on behalf of this Company, that we shall be most happy to undertake an experiment, such as we at first proposed, on some such terms as the following:—

1. We shall be permitted to utilise a portion of one or other of your present depositing tanks for the purpose of treating a measured quantity of raw sewage, say, 150,000 gallons per diem, making such additions at our own cost as we may deem necessary.

2. The Corporation shall supply us with what ashes we may require, delivered at the works.

3. We will find the necessary charcoal, on the condition that we take the products, supplying all the labour for working the same.

4. In case the results be satisfactory, the cost of the entire experiment shall be defrayed by the Corporation.

I am, sir, your obedient servant,

E. JOHNSON, Manager.

P.S.—If you take the population of the Stoke Workhouse at 800 (and it sometimes exceeds this), your quantities are reduced 20 per cent

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8, Great Winchester Street Buildings, London,
September 26th, 1871.

G. S. Mathews, Esq., Secretary to the Sewage Inquiry Committee, Birmingham.

Sir,—In continuation of my letter to you of the 21st inst., and replying to your letter of the 22nd inst., I am instructed now to write and say that this Company is prepared to treat the sewage of Birmingham on the following terms:—

1. The Company would, upon an annual subvention of £6,500 being paid to them, engage to deliver an effluent water from the sewage which should, on sufficient authority, be deemed of such a standard of purity as to be admissable into a stream.

2. The agreement to last for a period of twenty-one years.

3. The Company in making this offer proposes to carry it out by the formation of a separate Company.

Appendix X. — I am further instructed to state, that the Company does not consider it desirable to treat the sewage of the Muntz Street district separately, inasmuch as the expense and labour of so doing would be proportionately much larger there than the size of the place would render expedient.

I am, dear Sir, yours faithfully,

W. LOSSDALE,

Secretary to the Phosphate Sewage Company, Limited.

APPENDIX XI.

Statements received by the Committee from:—

Mr. George Shaw.

Mr. J. Houghton.

Mr. C. F. Cotterill.

Mr. Edwin Chesshire.

Mr. C. Chattock.

Mr. F. Bird.

APPENDIX XI.

STATEMENTS RECEIVED BY THE COMMITTEE.

STATEMENT OF Mr. SHAW, September 11th, 1871.

1. The CHAIRMAN: I believe you are by profession a patent agent, Mr. Shaw?—Yes.

2. If I am correctly informed, for ten years you were Professor of Chemistry at Queen's College?—Somewhat more than ten years.

3. And I presume that you have observed the serious difficulties which now embarrass the Corporation, with regard to the disposal of the sewage of the town?—Yes.

4. And also that two injunctions have been obtained: one of them restricting the Corporation from accumulating the slush or sewage at Gravelly Hill, or depositing it, or disposing of it in tanks or reservoirs, or disposing or dealing with the sewage, or any part thereof, in such a manner as to be a nuisance. These are the general terms of one of the injunctions; and the other injunction, that which refers to the great bulk of the sewage, is to restrain the Corporation from dealing with it so as to create or continue the nuisance complained of, or to pollute the River Tame so as to render it injurious to the health of the persons adjoining its course, or so as that it may be offensive and unfit for use, or injurious to health, when it passes through the grounds of the plaintiff, Sir Charles Adderley. Those are the general terms of the injunctions; I presume your attention has been directed to both of them?—Yes.

5. Then, having regard to that state of things, it is proposed, among other propositions, to deal with the sewage by purchasing some thousands of acres of land, whereby it is alleged that it may be both purified and utilised. The committee would be very much obliged for your opinion—first, as to the possibility of so purifying it; and next, as to the effect upon land which would result, either immediately or in a series of years, from so treating it?—If the sewage of Birmingham is to remain in its present condition, I think there is no method whereby it can be sufficiently clarified to be poured into the River Tame, but the plan which has been proposed, namely, the treatment by land; but were the organic matter, the human excrement, kept from the sewage, I think there would be little difficulty in so treating the products which arise from the manufacturing processes carried on here, as to render the sewage fit to be put into the Tame. I believe the land to be the only thing that is capable of absorbing what the sewage contains; but I do not think the sewage of a manufacturing town can be permanently beneficial to agricultural land. I may add that the sewage of such a town as Birmingham is of

Appendix XI. — Mr. Shaw.

very uncertain composition, varying from day to day; and no observations on the composition of that sewage, unless they extend over a long period, and are taken at short intervals of time, can give an accurate notion of its constitution. For example, in the case of certain processes in metallic manufactures, such as the galvanising of iron and the dipping of brass goods, considerable quantities of spent acids are poured into the sewers. If this occurs when, by reason of rain, there is a considerable quantity of water also present, these acids will be so much diluted that possibly they might not be injurious to the land; but if these acids are put into the sewers when little water is present, they would be poisonous to the land and destructive to vegetation.

6. I may tell you the number of premises within the borough is, as nearly as possible, 80,000, and that it has been ascertained that out of that 80,000 about 4,000 only contain water-closets. Some of them, of course, contain several water-closets. Now, considering that proportion, what is your opinion—first, as to the effect of excluding all human excreta, both solid and liquid, from the sewers; and next, of excluding the solid portion only from the sewers, and whether it is not the part of the sewage consisting of human excreta, and especially the solid parts of human excreta, that constitute the great difficulty of dealing with the sewage, either by filtration, or by deposit, or by irrigation, or by any other known means?—Human excrement is, undoubtedly, the most precious of all manures, and its proper destination is the land. The carrying of that manure to the land by means of water is the most costly method that could be resorted to; but we must take things as we find them. As a fact, we know that there is in the sewage matter of Birmingham a large quantity of organic matter, and this, *per se*, would be beneficially absorbed by the land; but, since it is mixed with a large quantity of inorganic matter, which is not only of no use, but, I think, positively injurious to the land, the treatment of such sewage presents great difficulties. I suppose there is no possibility at present, though no doubt it will be done in the future, of keeping out of the sewers, human excreta. In the absence of that, it appears to me, the only practicable plan is to take possession of a certain sufficient quantity of land, highly absorbent and porous, and, getting rid of all notion of benefiting it—which, I think, is chimerical—to use it to clarify, and, to a certain extent, purify the sewage water poured on it. The land will act as a filter, and, arresting suspended matter, will leave the water in a clear state. You will also get rid, at the same time, of a great deal of soluble matter.

7. Returning to your answer to one of my former questions, in which you referred to metallic substances and acids contained in the sewers, and which you said are injurious to vegetation, I shall first direct your attention to that iron pipe. (Corroded iron pipe produced.) This pipe is stated by the Borough Surveyor to have been fixed for six days in a drain leading from a galvanising establishment, and it is now thoroughly corroded. Is it your opinion that, so long as the sewage contains the acids that have produced this effect, it would either be so certainly hurtful or so probably hurtful to vegetation, that this would be a serious obstacle to farmers voluntarily using it for the purpose of irrigation?—Owing to the varying composition of the Birmingham sewage, from the cause I have pointed out—namely, that at uncertain and unknown times large quantities of deleterious matter are poured into it—I should not, as a conscientious man, feel at liberty to invite agriculturists to make use of

it, unless I had by some previous treatment assured myself, that it no longer contained acids or saline matters, likely to be injurious to vegetation. If agriculturists were chemists, they might, by a preliminary testing, assure themselves of the fitness of the sewage before putting it on their land; but in the absence of that power on the part of agriculturists, and in the absence of means taken by you to secure a wholesome condition of the sewage, it appears to me you are not justified in offering it to agriculturists. That certain poisonous effects have, or are believed to have, resulted from the use of the sewage is, I presume, patent to all of you. I have been assured by an agriculturist, a few miles from here, that on no account would he allow the river Tame containing the town sewage to pass on his property. He showed me a patch of land on which there had been something evidently poisonous; he attributed its barrenness—and I think he was probably right—to the poisonous character of the sewage water which had formerly been put upon the land.

8. I may tell you, as a question of fact, that at the sewage farm at Saltley, a farm which has now been under sewage cultivation for three or four years, though some of the crops have been occasionally disappointing, very frequently they have been quite luxuriant and abundant. Entertaining the views you have expressed, will you kindly explain how that state of things is likely to exist?—Yes. I will take as a typical illustration of the acids I have referred to, the spent liquor of the galvaniser. That consists of dilute sulphuric acid, in which the iron has been steeped for the purpose of dissolving oxide from its surface, until the acid is only partially saturated. After the acid becomes weakened to a certain extent, it is thrown away. The manufacturer thus pours into the sewer a solution of photosulphate of iron, *plus* a considerable quantity of free sulphuric acid. It may happen that another manufacturer is concurrently pouring in some lime, or alkaline compound, which will neutralise the acid, and the result may be a perfectly innocuous sewage. But this only occurs by accident; you have no power to command it, and it cannot be calculated on. Whenever that spent liquor, containing a large quantity of free acid, gets into the sewage, unless it is neutralised by some alkaline or earthy ingredient, or diluted by a large rainfall, I think it must necessarily be injurious to the land.

9. It is hardly necessary to remind you that Birmingham is a manufacturing town, and that the prosperity of it is entirely dependent on the manufacturers, and the facilities they have for conducting their trades. Now, in your opinion, would it be any very serious inconvenience to them either altogether to exclude the deleterious matters, to which you have referred, from the sewers, or to require them so to treat those matters, by some preliminary process, as that they should not be injurious to vegetation?—Of course there would be some little expense, but there would be little difficulty in so treating those spent acids as to make them in all cases innocuous, and in some cases positively beneficial to the land. Take, for example, the spent liquor of the galvaniser. That, being treated with lime, is brought into a perfectly harmless state; the lime neutralises it and precipitates the whole of the iron in the shape of protoxide of iron. In the case of the brassfounders' acids and washings, the introduction of lime forms nitrate of lime—a positively beneficial substance, and a valuable manure in itself. It is simply a matter of cost, and that not very great. There are no other difficulties, whether the manufacturer himself does this, or you allow him to put the deleterious matters in the sewage and then, by a treatment at the outfall, yourselves neutralise them.

[illegible]

Mr. Hill.

[illegible] —He would [illegible] and the [illegible] small. I know of no [illegible] a waste product, [illegible] the manufactures.

11. Mr. [illegible] —I take it from you that you believe the manufacturers of [illegible] are of [illegible] the sewage could be passed on to the land permanently without it being [illegible]? That is so. I presume, is it not the fact that you [illegible] —I have had experience in the practical [illegible].

12. You say that in the particular case a former Bill point out some land [illegible] by sewage —Yes.

13. Did you find that to be true that was really raised!—No.

14. I presume you have seen the analyses that were prepared some time ago for the Public Works Committee by Dr. Hill and Professor Voelcker —Yes, I have seen them.

15. You saw that the analysis of Dr. Hill extended over some considerable period, almost sufficient for it [illegible] to an average!—I forget how long a time it extended over.

16. A fortnight, I think!

The CHAIRMAN: Yes, about that time.

Mr. TIMES: You saw that both of the analyses referred to no contaminating substance with the exception of sulphate of iron!—I think there was a minimum of other metals.

17. There were traces of copper and zinc in one of the analyses, but mere traces!—Yes, I recollect the presence of them, but not the quantities.

18. You would not anticipate any injury to land from the presence of either copper or zinc in a metallic form, or in the form of an oxide!—No, I should not, in small quantities.

19. These traces, probably, were in that form! That, of course, you cannot say!—I cannot say.

20. Then it would appear from these analyses that what we have to deal with practically in Birmingham is the sulphate of iron and the free sulphuric acid!—Let me, if you please, say with reference to the analyses, I was much surprised, on examining them, to observe no sulphide or sulphuret of iron. Now, it is within my knowledge that considerable quantities of that, some years ago, were to be found in the sewers. I do not question the accuracy of the analyses, but that fact, I think, shows how necessary it is, before coming to any conclusions as to the sewage of a town like Birmingham, to be armed with a series of observations extending over a long period, and taken at very short intervals. I say it is within my knowledge that some time ago there were considerable quantities of sulphide of iron in the sewage. Primarily it must have come from the

galvaniser in the form of sulphate. The sulphide was produced by a neutral condition of the sewage, and the precipitation of the iron under this condition, by sulphur derived from the excrementitious matter. At one time the requisite conditions obtained largely, and the whole of the iron, was, I believe, in the form of sulphide. Now, it does not occur in these analyses; and this alone shows how important it is that no individual observation should be regarded as a sufficient guide to action.

21. Then, with reference to this sulphide of iron, is that a compound which is very stable?—Under some conditions sulphide of iron rapidly oxidises; under others it is stable. To what extent it would oxidise in the soil depends on conditions which could hardly be anticipated.

22. When the sulphide has passed into the state of sulphate, would it not probably in a very short time pass into the form of peroxide of iron?—A perfectly neutral solution of sulphate of iron rapidly oxidises on exposure to the air, a part only of the iron being precipitated as peroxide.

23. Probably your knowledge of agricultural chemistry enables you to say that peroxide of iron is not injurious?—It is an inert substance, and not injurious.

24. Are you aware that it is found in the most fertile land, to the extent of 3 to 11 per cent?—It is almost universally a constituent of good soil, and one of the most commonly diffused things in nature.

25. Supposing there were any free sulphate of iron in the sewage, would you anticipate any mischief to vegetation?—I do not imagine that a moderate quantity of solution of sulphate of iron, perfectly neutral, poured on land would be very hurtful. Much would depend on the state of the plant. When it has obtained a certain maturity and growth, it has, like animal organisms, a wonderful power of throwing off or rejecting anything that is injurious to it; but an exceedingly young plant is very tender, and, as in the case of a young animal, what would not kill an older one, would injure or kill it.

26. Would you be surprised if I told you that I recently made an experiment of growing grass from the seed watered by a solution of five grains of sulphate of iron to the gallon, and a solution of ten grains of sulphate to the gallon, and also another lot watered with ordinary water. It is now about a foot high, and the result of the growth up to the present time has been that the plant which was watered with the ten-grain solution is the most vigorous, that watered with the five-grain solution is the next, and the worst plant of all is that which was watered with pure water?—I am not surprised at such a result. But such experiments are not to be regarded as trustworthy, unless all the conditions are carefully observed. Are you sure that the instant the sulphate of iron came in contact with the soil it was not decomposed? The plant might never have been touched by the sulphate of iron. If the soil contained lime, for example, the sulphate of iron would be instantly decomposed. We know that sulphate of iron is not only no part of the composition of a good soil, but that in no conceivable way, so far as the present state of vegetable chemistry enables us to judge, can it enter into, or minister to the growth or welfare of, the plant. It may be perfectly innocuous, but it cannot be useful. The probability is,

Appendix XI. — Mr. Shaw.

that this and all analogous salts, if they had any effect, would be injurious.

27. That is stated as a probability, not from experience?—I have no experience on the subject.

28. Dismissing for the moment the sulphate of iron, you say that from the various galvanising and ironware works a quantity of free acid passes into the sewers. Is it not probable that free acid would meet with various substances—ammonia, and such like—with which it would combine and become neutralised before it reached the sewers outfall?—I have no knowledge of anything that would bring about such a state of things. That it does occasionally occur is clear from what I have already said—that the sulphate does sometimes become neutral, or the sulphide of iron would not be formed. Whether that is frequently the case I do not know. I know of no manufactories from which anything of an alkaline or basic character would be poured into the sewers.

29. Do you know the reaction of the sewage at the outfall?—I have no experience of it. I believe, from the analyses published, it was alkaline.

Alderman HAWKES: Slightly alkaline.

Mr. SHAW: I was surprised at that, as if it had been alkaline I should not have expected to find sulphate of iron in solution.

Mr. TONKS: Should you infer from the analyses that the iron was found there in the form of sulphate?

Mr. SHAW: I may say, with regard to those analyses, I never had possession of the book containing them. All I know of them is, from a brief glance at the printed copies, which a gentleman put into my hands for a few minutes.

30. Apparently there is a discrepancy between the analyses of Professor Voelcker and Dr. Hill. It probably might be explained, but on the face of it there appears a discrepancy—that is, Dr. Voelcker describes the iron as present in the form of photosulphate, whereas Dr. Hill describes it as principally in the form of peroxide. Of course that is a very important distinction?—Yes. The iron must have been exposed to oxidising influences in the one case, not present in the other. But I understood that the analyses were made on the same sewage; that a portion of sewage was taken and divided between them.

31. What actually occurred was this: the sewage was taken for fourteen days, I think—I am not quite sure about it—and Dr. Hill gives an analysis for each day. The sewage of one day was sent to Professor Voelcker.

Alderman HAWKES: Dr. Hill says, "Samples of each day's sewage for an entire week." A sample of sewage of Friday, the 5th of May, was sent to Dr. Voelcker.

Mr. TONKS: If the sewage gave an alkaline reaction, would you expect iron to be present in the form of oxide or sulphate?

Mr. SHAW: I should expect it to be present in the form of oxide or sulphide. I cannot conceive the existence in the same solution of a free alkali and sulphate of iron, excepting under conditions not to be expected in sewage.

32. Then if it could be shown that the sewage was always alkaline, you would expect that the sulphate of iron would no longer be injurious to

the land?—The salts of iron could not be present in solution in sewage with a free alkali.

33. Then, in that case, the manufacturers' products, so far as concerns the salts of iron, could not be injurious to the land?—Though there would be no iron salts in solution, oxide or sulphide of iron might be in the mud, and carried in suspension to the land.

34. I may say that we recently had some conversation with Mr. Pritchard, the civil engineer employed on the sewage farm at Warwick; and he said he had inspected the crops growing on the Saltley farm, and, so far as he was able to observe, he should say that the sewage there had produced no mischief whatever, but the ordinary effects produced by sewage irrigation. He could find no traces of any mischief being done by the sewage being mixed with manufacturers' products?—I have never seen the sewage farm at Saltley, and the Committee must pardon me if I decline to express an opinion, or enter into a discussion respecting it. If you will allow me to say a few words with respect to soil and plant growth generally, it will, probably, facilitate the further discussion of the subject. If we take a perfectly good soil and grow a plant on it, the plant in growing takes up certain constituents from the soil; they are very minute in quantity, but very definite in character. If we restore to the soil precisely what the plant has taken from it, and do that every time the plant is grown on it, the soil will retain its original fertile character. Now, the principal, if not the only thing in your sewage, of value to the soil, is the saline matter of your excreta, which closely resembles the saline matter removed therefrom by the plant. But with that you take tons and tons of matter which, whether injurious or not, is certainly not necessary or desirable to the land. The only thing a plant takes by its roots is water, in very large quantities; and next, saline matter, in very small quantities. If we burn a plant, there remains behind a certain small amount of indestructible matter which we call "ash." That consists of the fixed mineral matter which the plant has taken from the soil, in addition to a large quantity of water. The water we may disregard, because the heavens send that.

Alderman HAWKES: Well, it comes from somewhere.

Mr. SHAW: Now, whether or not the manufacturers' products are, by a directly poisonous character, injurious to the land, certainly they are unnecessary; and in lapse of time, if they do not by their chemical action injure the growth of plants, it is to be feared that by their mechanical action, they will injuriously interfere with the nature of the soil.

35. How many years do you expect it would take so to alter the area generally considered to be necessary to purify the Birmingham sewage one per cent. as to its peroxide of iron?—I am afraid that must be pronounced an insoluble question.

36. You say the only valuable matter is the salts obtained from the human excreta?—Yes, speaking generally that is so.

37. Are there no sources of salts which are beneficial to vegetation besides human excreta?—Yes; nitrates and ammoniacal salts, which are valuable, if not necessary, to plants, may be derived from various sources, as indeed may all the salts in human excreta. To return to the relation

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of the soil to the plant. A plant consists mainly of carbon, hydrogen, and oxygen. The oxygen and hydrogen are commonly in the proportions in which they form water. A piece of wood—I speak only of the fibre—is composed of these three elements, so that we may regard cellulose as water *plus* carbon. All the carbon of plants is derived from the air; every leaf is a true lung. By the root they take in only water and the minute portions of saline matter already referred to. Early in its growth the plant forms nitrogenous compounds only sparingly, but as it approaches maturity those compounds are formed largely, and to the greatest extent, shortly before its temporary or permanent death. The plant is the only organiser of matter. It takes inorganic matter from the air and soil, and, by a series of very beautiful chemical changes, many of which are now well understood, builds up the most complex organic compounds found in nature. The compounds formed by the plant are the only food of the animal, and from the time they enter the animal system as food, they undergo degradation. When the matter taken as food passes away from the animal it is inorganic, or nearly so, and ready to be again taken up by the plant; and so the round of organic changes goes on. The way in which the plant assimilates nitrogen, is not yet known. It is doubtless derived, mainly, if not wholly, from compounds containing it, such as nitric acid and ammonia; but the nature of the changes by which it becomes part of the living organism, is wholly unknown.

38. But there are other things, besides those which you have referred to, which are essential to plants; that is to say, the salts of potash and soda in the ashes of plants. Are there no other sources of potash and soda than those contained in the human excreta?—Yes, many others.

39. Then the potash and soda passed off in the sewage would be beneficial to vegetation?—Yes.

40. I understood you to say that the only portion of the sewage of towns that is valuable for vegetation is the portion derived from human excreta. I wish to arrive at the information as to whether there are other sources, besides human excreta, which will provide valuable food for plants. I would suggest, for instance, that the potash and soda contained in soap—which is, of course, used in large quantities, and passes into the sewage—would also be a valuable addition to the sewage for the purposes of cultivation?—Whether the materials in question come from human excreta, or are obtained from any other source, cannot affect the question. So long as they are restored to the soil, it does not matter where they come from. Alkalies are valuable; but if you say alkalies in the form of soap, I am not so clear about it. If it were the alkali, and not the soap, it would be valuable; but soapsuds are of doubtful value. We know they are commonly thrown on land, and the alkali is a valuable material; but there is the other constituent—the fatty element—the stearic acid, for example, which is not only of no use, but is a most inert substance, and would, in time, probably clog up the soil and injure its character physically, if not chemically. I should like to impress upon you the great superiority of animal excreta over other manurial matters, in the respect, that these contain all the fixed ingredients which the soil is ordinarily in want of; and although alkali from one source, and phosphoric acid from another, and the other ingredients from other sources, would, if mixed in like proportion, have the same effect as the same ingredients derived from excreta, yet such a combination can never occur

in sewage. It is in excreta alone speaking generally that we find the right ingredients in the right proportions. The occurrence of any one manurial element—alkali, for example—must not have a too great importance attached to it.

41. You have told us before, you have no experience practically in cultivation. Now, as a matter of fact, cultivators have affirmed the use of soapsuds to be extremely beneficial?—No experiment with soapsuds has extended over sufficient time, or been made on a sufficient scale, to yield results of a trustworthy character. The soapsuds of a house might be thrown for a time on a large garden or field with advantage, but such an experiment is not parallel with what would take place if the washings of a town were continuously, and for a long time, thrown on agricultural land. Before leaving this part of the subject I would remark, that the potash in sewage, derived from soap, must be insignificant in quantity, as it is the alkaline constituent of soft-soap only, of which little is used. The alkaline constituent of common or hard soap is soda. This may indirectly be valuable, probably by making soluble and rendering absorbable some constituents of the soil required by the plant. But potash is the essential alkali of land plants, and soda that of marine plants.

Mr. HARRIS: You were telling Mr. Avery there were two methods of dealing with the ingredients from ironworks and brassfoundries, and you say the manufacturer himself might neutralise them at his own works, or we might neutralise them at Saltley. I should like to have your opinion, if it is within the scope of your knowledge of the subject, whether it would be cheaper or better for the town generally to ask or compel the manufacturers to do this, bearing in mind the uncertainty of the contribution. We shall have to go on treating the sewage constantly, whereas they would only treat it when they knew it was necessary. Would it not be wiser, as a matter of public policy, to ask the manufacturers to do it themselves?—If you were going to make use of the sewage on land of your own, devoted entirely to clarifying, and partly purifying, the sewage, I think it would be of very little consequence which you did. But if you offer it to the farmer on the way, I think you are morally bound to take care, that you are not offering to him poison in place of food; and I therefore think it is incumbent on you to treat it yourselves, for then only can you know that it has been properly treated.

42. A large number of ashpits are connected with the sewers in addition to water closets. and send solid matter down.

The CHAIRMAN: There are about 14,000.

Mr. MATHEWS: Between 13,000 and 14,000 turn into the sewers.

Mr. HARRIS: Each of these receives excrement from many dwellings. Supposing we kept this out of the sewers, and were, as far as possible, to decrease the number of water-closets, at the same time preventing animal refuse from slaughter-houses, &c., from going into the sewers, would it not facilitate our process of purification, either by precipitation or otherwise, at the outfall? Would it not be so great an assistance to us at the outfall as to render some expenditure desirable to effect the object?—I am labouring under some little difficulty with regard to the relation of the ashpits to the sewers. Is the communication direct, or does the matter percolate through any considerable stratum of soil?

43. A drain-pipe is taken into the ashpit itself, sometimes covered over with an iron grating, sometimes not; soil from the privy passes

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through the seat, and household ashes through the door. It is open to the rainfall, and rain and household water are constantly soaking through this amalgamated mass of ashes and excrement, and draining directly into the sewers?—In so far as the excrementitious matter had not undergone decomposition, it would still retain its property of becoming putrescent, and a public nuisance; but all those things which are capable of becoming putrid do, in the act of putrefying, pass into inorganic forms of matter which are positively beneficial to the soil. The offensive odour which recent excrement has, is the result of a series of decompositions which it is at the time undergoing. We may take all this decomposing matter in excrement as being albuminous matter in a state of decomposition. Albumen is one of those very highly nitrogenised compounds which I spoke of, as the ultimate product of plant growth, and the only compounds that can minister as human food to the formation of tissue. When in a state of decomposition, albuminous matters evolve two very offensive volatile compounds—one, sulphuretted hydrogen (for albumen contains minute quantities of sulphur), the other, butyric acid; and it is these two stinking things which principally constitute the offensive character of fœcal matter. But these decompositions are but stages—links in a chain or series of decompositions, by virtue of which the decaying matter passes ultimately into carbonic acid, water, ammonia, and nitric acid—inorganic forms of matter which the plant is ready to absorb as its proper food, and form again into food for us. So far, as the matter from the ashpits has not yet decomposed sufficiently to be inodorous, it would create a nuisance; but, whether odorous or inodorous, it would be very valuable for land, and if the decomposition has not been completed before you put it on the land, it will be completed there. So far as a nuisance is concerned, the drainings will probably be bad, but for agricultural purposes they will be valuable. Do I answer the question you intended to put?

44. Scarcely. We shall have, as you say, to try to neutralise whatever injurious products are in the sewers before we invite farmers to take the sewage. Will our process of purification be simplified, and made cheaper, if we keep out of the sewers the drainage from the ashpits?—The only thing you have to offer the farmer, which is of any value, are these very products. He does not want the sweepings of your streets, Rowley rag, and the immense quantities of mud and slush you take down. The only useful thing, speaking generally, is this excrementitious matter.

45. Whether it be useful for agriculture or not, supposing we find we are bound to adopt some process of precipitation, would that process be rendered cheaper and easier by keeping out the drainings from the ashpits?—The process you will resort to for precipitating the mineral matters in the sewers will not touch these organic compounds, which are more or less soluble. Once get them in the sewage, you cannot get them out again; the land will do that, and nothing else will. You can precipitate the saline matters, but you cannot remove the organic matter.

46. I did not ask you what was valuable in the manure. I said, supposing it were in our view to purify the sewage by precipitation, would not that be much assisted and made cheaper if we kept out the refuse from the ashpits?—No process of precipitation you can adopt will ever touch these things, either for good or ill.

Alderman HAWKES: I have handed to you a copy of Dr. Voelcker's description of the bottle of stuff sent to him on the 5th of May. I

handed it to you with this view—that if you gave opinions on the constituents of our sewage without referring to it, you might say, after casting your eye over the description by him of the sewage so sent to him by the Public Works Committee, whether any answer you have given is altered by a reference to it?—I should hardly like to express a decided opinion respecting these analyses, on so cursory a glance as I have given to them. I know Dr. Voelcker well. He is a most competent man, and, I believe, most careful and conscientious. I should place great reliance on what he has said; but I have all along felt that to rely on analyses taken from individual samples, and, indeed, to rely on anything except analyses extending over a long period, would necessarily be unsafe.

47. Then I draw your attention to the fact that the analysis of the Birmingham sewage by Dr. Voelcker is simply an analysis of Birmingham sewage taken on Friday, the 5th of May, in the present year. There will be several questions of dryness, or amount of water, &c., on that day. But what he writes upon is the sewage sent to him, collected on Friday, the 5th of May; and that is the only sewage he speaks about?—In order to make such an analysis of value, I think it requires to be supplemented by many others. It represents the composition of the sewage at the time it was taken, but nothing more. Had it been taken early on a Monday morning, instead of on a Friday, the result would have been very different. The analysis is valuable as far as it goes, but for any purpose of action it is useless.

48. Assuming that the sewage of Birmingham was 17,000,000 gallons a day, what might it not amount to in a rainfall of twenty-four hours?—I should hardly like to answer the question without making a calculation.

49. Would it be six or seven times as much?—Probably; but in the absence of definite data, I cannot form a confident opinion.

50. You have said that the only constituents of the Birmingham sewage which would be in any wise valuable as manure are the human excreta, solid and fluid?—Yes, or compounds of the same kind from any other sources. All the other constituents, I think, are simply obstructive and worthless on the land.

51. Therefore, if the Town Council adopted means to exclude from the sewage human excreta, are there, in your opinion, similar elements sent into the sewage from other sources to make the sewage available as manure?—No, except in a very limited degree. Soap is, I believe, the only thing likely, by the alkali it contains, to be of any use for agricultural purposes; and I have doubt as to its value.

52. Now, Dr. Voelcker advises the compelling of certain manufacturers to keep out certain acids. Supposing that the Town Council excludes human excreta from the sewage, are you able to give us an opinion whether the coercion of these manufacturers, and the hindrances to the industry of the town, for the purpose of selling this impoverished sewage—this soapsud sewage, would be a judicious step? Whether, having taken from the sewage all that is valuable, you would, with Dr. Voelcker, consider it expedient to alter the action of all our great manufactories for the purpose of selling what you say would be merely rubbish?—I do not conceive that your sewage would have any real value, if you took the excreta away.

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53. And, therefore, legislative coercive measures against manufacturers to sell that utterly worthless stuff, you would not advise?—Certainly not; when you keep the excreta out of the sewage, you will have done with the agriculturist, and there can no longer be any object in requiring manufacturers to keep out of the sewers, matters injurious to the land. You can yourselves readily treat the sewage, so as to fit it to be poured into the river.

54. The other question did not enter into my mind at all, for we are not under any direction to make beautiful rivers. We have nothing to do except with certain nuisances?—That nuisance being to the nose or to the fish?

55. We are enjoined not to put our sewage into the river so as to be injurious to the health of certain people, and we may say health generally; but we are not under injunction as to the lower animals?—My impression was, that you were to put the water into the river in such a condition that it would not injure fish.

The CHAIRMAN: No.

Mr. TONKS: I think evidence that we killed the fish would be very conclusive to the Vice-chancellor's mind.

Alderman HAWKES: Now, we were talking about stinks. You have heard that there are 13,000 middens turned into the sewage, and a few thousand water-closets. That, I may state as a fact, does not reach over half the town. It is not a water-closet town, nor is it a midden town in connection with sewerage yet. Both are in a very imperfect state. Suppose the Privy Council compel us to turn everything into the sewers—the excreta of 345,800 inhabitants. Suppose we turn that sewage, so improved, so enriched, by three times the present quantity of excreta, and deluge certain lands with it between here and Tamworth or Water Orton, day by day throughout the year, in your opinion would that create a nuisance by stench injurious to health?

Mr. SHAW: The course you describe seems to me so—I was going to say, insane, that I can hardly imagine any community to be guilty of it. That any community should take such an enormous mass of liquid filth as that you describe, and pour it on a valley which, being already saturated or largely charged with water, has little or no absorbent quality, is a proposition so wild, that I should have thought it could never enter the mind of man. The only way to dispose of such matters is to take them on to a highly porous, quick-filtering soil. To deposit them in a valley already charged with water, is to do little towards the removal of your difficulty.

56. There are persons who think it a proper thing to do. Supposing it is done, as a chemist, what should you think would be the effect on the human senses of the stench on the area of the land, in the trenches, in the ditches, and in the hollows along which the sewage would settle?—It appears to me that the effect of the scheme you describe would be to create a huge putrescent lake, not to get rid of your difficulty. Your object is to get the sewage into the land as quickly as possible.

57. At present about one-third of the human excreta of Birmingham, solid and liquid, is sent into the sewers. Now, suppose the town is made complete by sending all into the sewers. You have been at Saltley?—Yes.

58. Supposing that outlet pipe is elongated along the Tame Valley, and then this sewage is allowed to rush on certain lands which we secure—5,000, 6,000, or 7,000 acres. Would the effect of that be the putrescent lake you speak of?—If the sewage is poured on a low plain, certainly; if on high land, it would be absorbed, and the nuisance would be abated.

59. Several times it was remarked to you by Mr. Tonks that you had had no practical experience as an agriculturist?—I have had no experience in the practical operations of agriculture.

60. Are you able to say that your chemical knowledge is so impaired, for want of practical knowledge of agriculture, as to be such we cannot rely upon?—With respect to the matters under discussion, we have little or no experience to refer to, and consequently little light to guide us, save that which abstract science affords. The chemist knows much respecting the nature of soils and the phenomena of plant growth, which the merely practical agriculturist does not know. The knowledge I bring to bear on the subject is of an abstract kind—chemistry, and vegetable physiology. In answer to the question which has been so directly put, I hope it is not inconsistent with modesty for me to say, that I would rather rely on my own opinion as to the probable effects of the acids in the Birmingham sewage upon growing plants, than on that of any farmer in the Tame Valley.

61. Mr. Tonks examined you very minutely as to the growth of certain grasses he has been experimenting upon?—I think, with regard to Mr. Tonks's experiments—and I am sure he will be obliged to me for being very plain—just as I do with respect to Dr. Voelcker's analysis: they may be very valuable, supplemented by other things; but in the absence of that supplementary matter, it would be unsafe to build any conclusion upon them.

Mr. JESSE COLLINGS: My question somewhat goes back to Mr. Harris's which I had down in another form. I will put it in this way: At present we have 18,000 water-closets and middens draining into the sewers, also cow-houses and slaughter-houses—I do not know how many. Supposing we could keep out of the sewers a good portion of the sewage from the water-closets and all the sewage of the middens, say that, roughly speaking, we could reduce the amount of excreta to about one-tenth of what it is now, and that this one-tenth was mixed with the 18,000,000 gallons of water that now goes daily into the sewers. Would that amount of excreta, mixed with that amount of water, be sufficient to create a nuisance in the subsidence tank? Would it be sufficient to make the roadstuff and the water we get down there stink?

Mr. SHAW: I think not. This solid matter is mainly mineral or inorganic matter, and it stinks only by virtue of the small quantity of feculent matter remaining in it. If it were reduced to the quantity you speak of, I think there would be no practical nuisance from it. But that difficulty may be overcome in a way perfectly practicable in the present state of things. That matter which you dry, only stinks by virtue of the excremental matter mechanically contained it it. By a process of washing—and it would not be very difficult—you may remove from the matter at Saltley the greater part of the organic matter which it contains.

62. If we could keep the matter I speak of to about one-tenth of the

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present quantity, would it be safe to let that run into the river?—I think so, decidedly.

63. If we could shut up the 14,000 middens, and 2,000 out of the 4,000 water-closets, leaving about a one-tenth part of the human excreta, and the road droppings, and so on, it might, without injury to the health of the neighbourhood, be allowed to run into the river?—I think so.

64. In the Council, we hear that irrigation to the roots of plants and growing vegetation is absolutely necessary to cleanse the sewage. Now, if we took the land as a filter, without growing plants at all, would letting the sewage pass through the land as a filter be quite sufficient to purify the sewage, without any growing plants?—I think it would. Land really is that compound thing called a chemical filter. It acts both mechanically and chemically. By virtue of its porosity it acts mechanically, and arrests suspended solid particles, thereby clarifying the water. Besides that, some of the dissolved matters would be removed by the soil, and the water would be partially purified.

Mr. TONKS: Do you believe the sewage could be purified for an indefinite time on a limited quantity of land?

Mr. SHAW: Such a thing would be both a physical and a chemical miracle. A filter, mechanically, is but a sieve, the pores of which must inevitably get stopped up sooner or later, by the matter it arrests. The act of arresting is itself, a stopping up of the pores. The same loss of power would occur in the chemical action of the soil. Chemically, the soil only absorbs sewage by virtue of its containing something, with which the dissolved matter in the sewage can combine. When this combination has taken place, the chemical action of the soil is at an end.

Mr. COLLINGS: Then the strong assertion made as to plants being absolutely necessary to the purification of sewage is not correct—land will do as well?

Mr. SHAW: Of course the plant, in growing, would take up that minute quantity of mineral matter proper to its composition.

65. Suppose we had two pieces of land, the filter, although stopped up, would renew itself, either by lying fallow or by being turned up? If you had two pieces of land, would the first filter renew itself while the other was being used?—To a considerable extent that would take place. But in all revivifying processes, the restored power is feebler than the original. The second time it is less than the first, the third time less than the second, and so on. By lying fallow, or being broken up, the land will preserve for a considerable time its purifying property, but eventually it must lose that power.

66. Suppose, then, we take two pieces of land to put our sewage on, somebody may get up and say, "Yes, but your land will be utterly worthless, and will become a nuisance in itself." If that will be so in a comparatively short time, it will be rather a fatal objection to any cleansing process?—The length of time during which the soil will be operative will depend on its nature and extent. But whether you take a small portion of land and sacrifice it, or take a large portion and try to make it profitable, in time both the one and the other will fail.

67. You used the term "putrescent lake" in regard to the pouring of a large quantity of sewage for irrigation on low lying places. If we adopted irrigation in the Tame Valley, and poured the whole of the Bir-

mingham sewage there, is there a danger of its becoming a putrescent lake? —I do not know much of the Tame Valley; I know it in certain points only. But, assuming it to be like river valleys in general, I think it a very unsuitable place.

Mr. HARRIS: Supposing that after keeping out of the sewers nine-tenths of the human excrement now going into them, it is still found necessary to adopt some artificial method of purification, would the cost be much less, and the process much simpler, than if the whole of the excrement were allowed to go into the sewers?

Mr. SHAW: Any artificial process of purification you resort to does not touch, in any material degree, those matters your question refers to.

68. And if they went into the sewers they would be still as great a nuisance as ever?—Quite so. I understood Mr. Collings to ask, "If we diminished the quantity of excremental matter in the sewage, would the drying of the solid sweepings of the streets create as great a nuisance as it now does?" I say certainly not, because if that matter, so drying, only contained one-tenth of the putrescible matter it now contains, only one-tenth of the nuisance would be produced. That mud at Saltley does not produce any stink of itself; it stinks only in consequence of the feculent matter which is mixed with it. If you could wash it, it would not stink at all; it is only because it is charged with very dirty water that it stinks in drying. Have I made myself clear?

Mr. COLLINGS: The question is this: If you reduce the amount of excrement to one-tenth, and send it down the sewers as you do now, would it be sufficient to make the solid stuff stink, and so prevent us from letting the liquid part run into the river undealt with?

Mr. SHAW: It would produce a faint odour, but so very low that I think it could not be regarded as a nuisance.

69. And going into the river without being dealt with by means of land or otherwise?—The liquid part, of course, would carry with it all its offensive characteristics in a low degree.

70. The practical end of my enquiry is this: If we kept out nine-tenths of the present feculent matter, could we treat the solid matter and allow the liquid matter to go into the river without fear of injunctions?—I think so, certainly. It would be diluted to ten times its present state of dilution, and, I think, would not then create a nuisaace.

Dr. BARRATT: Of course you are aware that other refuse from factories goes into the sewers, besides the acid solutions which have been referred to. I mean the refuse of tallow chandlers, and of tanners' yards. Would the introduction of such refuse into the sewers tend to increase the difficulty of beneficially acting on the matters at the sewage outlet?

Mr. SHAW: So far as my knowledge extends, the quantity of these matters is so small that that they may be disregarded. Tanning is not much carried on here.

71. It is increasing, I am informed, in the neighbourhood of the town, and so is tallow chandling?—The tanning refuse would probably improve the sewage, so far as fœcal matter is concerned.

72. I was referring to the commingling of the acid from factories and the refuse from tallow chandlers and tanyards, &c.?—I am not acquainted with the nature of the refuse which chandlers pour into the sewers.

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73. I presume the effect of the sulphate of iron passing through the sewers, with free sulphuric acid in solution, is injurious to the structure of the sewers?—It has a corrosive action on the mortar.

74. And would tend to render the sewers so porous that the matters in solution would percolate, and injure the wells, wherever they went?—That must necessarily arise, sooner or later.

75.—Would you, if possible, keep the excreta out of the sewers?—If it were possible and convenient, it appears to me that that is the only rational thing to do; and it is my firm conviction that the eventual solution of the difficulty, will be in that direction. Any measures taken for some time to come can be only tentative. The subject must receive (and I think soon) imperial consideration, and any course which we, and others in a like position, resolve on, must be regarded only as a temporary expedient to tide over a pressing difficulty. To think that we are solving the problem for good and all, will be, I think, to deceive ourselves.

76. Then you would, as far as practicable, keep out all excreta from the sewers?—I certainly would.

77. Then I want to obtain your opinion as to the sewage being mixed with 17,000,000 or 18,000,000 gallons of water. Whatever manurial value it had at starting, after being so largely diluted its value must to a large extent become reduced?—As I said before, I think to mix sewage with water is the most wasteful and extravagant method of carrying it to the land that can be resorted to. I could carry on the palm of my hand, in a very useful form, the really valuable saline matter of a quantity of sewage which at present is conveyed to the land by many tons of water, and which is less valuable (in consequence of the useless or injurious matter carried along with it) when conveyed in that way, than it would be if carried there on the palm of my hand.

78. And these matters coming to Saltley, and, of course, decomposition more or less rapidly going on all the time, the gaseous products of decomposition contaminating the atmosphere we breathe, do you look on it as prejudicial to the health of the inhabitants?—It is certainly disagreeable, but I am afraid our knowledge is not sufficiently exact on these subjects to enable us to speak with confidence on the physiological effect of these emanations. That the smell is disagreeable we know, and that is a sufficient reason for stopping it; but whether it is injurious or not we do not know. Many stinks are certainly not injurious. Instances might be cited, almost without number, where men are in vigorous health, who work every day in very bad smells.

79. These gaseous products extracting the oxygen we require, would they tend to injure health?—Strictly speaking, they would. Anything which abstracts oxygen from the air interferes with its wholesome condition, but in the case in question I think the effect would be inappreciable.

80. Do you think the unpleasant smells, by their mechanical influence on the individual, would tend to injure health?—Inasmuch as any disagreeable smell is annoying, and makes us uncomfortable, we have a right to object to it, and, if we can, to suppress it.

81. So long as this manufacturers' refuse—the sulphate of iron—in excess, is permitted to pass through the sewers, and become mixed with their other contents, would you consider it would be injurious, in a greater or less degree, to the plants?—I think the free acid would be injurious. In a fertile soil there is no such thing as sulphuric acid. It is not wanted by the plant, and cannot subserve any useful purpose, so far as our knowledge of these things enables us to judge. Physiological considerations lead to the belief that it would be injurious to plants, to water them with dilute sulphuric acid.

Mr. MATHEWS: Do you think it probable that a great part of the soluble portions of the excreta would enter the sewers through the drains of ashpits connected with them, or would the soluble portions be generally, except in rainy weather, absorbed by the ashes?

Mr. SHAW: That is a question of quantity—of how much ash was put into the ashpit in proportion to the liquid excreta. We know ashes are very absorbent, and they would absorb to the extent of their power; but whether they would take up half, or the whole, or any particular quantity depends on the amount of ashes and the amount of excreta.

82. You have said that fœcal matter is the only thing we have in our sewers worth offering to the farmer. Is it not a fact that simple water has always been largely used by agriculturists, and that they have laid out land to a great extent to receive it, in addition to the rainfall? Would not sewage be used for the sake of the water, even with ingredients which are not usually found in water, and not beneficial to the plants? —That water is necessary to vegetation we all know; but the water of sewage presents no difficulty, apart from the impurities contained in it. When, by prevention or cure, the sewage water ceases to be a source of nuisance, its disposal does not depend upon a scheme for irrigation; it may go direct into the river.

Mr. TONKS: Leaving out of the question irrigation, and consequently the condition of the sewage as a fertiliser, are not the additions from the manufactories—the manufacturers' products—such as sulphate of iron and the nitrates, positively beneficial to the sewage, as taking away from it a nuisance perceptible to the nose?

Mr. SHAW: When the sewage is in that abnormal condition in which it is sometimes found—that is, perfectly neutral, as I have already said, a portion of the iron falls down in combination with the sulphur of the fœcal matter, and to that extent a portion of the offensive matter of the sewage is removed. It is an exceptional state of things, but that it does occur to a certain minute extent there can be no question.

83. But are you aware that in one town in England the main ingredient they use to purify the sewage, or prevent it from becoming a nuisance, is sulphate of iron?—No, I am not aware of it.

The CHAIRMAN: I have one or two very brief questions to put on the evidence you have given. First, direct your attention once more to the condition of this iron tube, which, as I stated before, was used for six days to collect the sewage from a single manufactory in the town. It is proposed to construct a conduit of several miles in length for the purpose of conveying the sewage, and some parts of it it is proposed to construct of iron. Now, although those injurious elements, when mixed up with the other sewage, will be of course in a highly diluted form, in your opinion would they be, so diluted, injurious to the iron pipes forming a part of the conduit?

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Mr. SHAW: Necessarily so. It is a question of degree. There (pointing to the pipe) the oil of vitriol is diluted to a certain extent, and it has had, you see, a very rapid action on that pipe. If you dilute it to a double extent, the action would be halved. Either the manufacturer must be compelled to treat the acid matters with lime, to neutralise them, or it will be incumbent on you to do so. If you do not intend to offer the sewage to the farmer, you may leave it to the manufacturer; but if you do, I think it will be your duty to see that it is done.

84. Did I rightly understand you to say, that though the sewage may be at different times free from poisonous ingredients, or ingredients alleged to be poisonous, yet that generally it will contain them in such a concentrated form that, with that knowledge, you could not conscientiously offer the sewage to farmers while it did so contain them?—I could not; and, were I a farmer, I would on no consideration take from you sewage liable to contain those compounds.

85. And, therefore, I understand you distinctly to express your opinion that it is either the duty of the Corporation to neutralise these alleged poisonous ingredients, or to take care that the manufacturers do so, and that it would not necessarily be a very costly and troublesome process to them?—That is my opinion.

86. In reply to a question of Mr. Alderman Hawkes, I think you said that human excreta were the only valuable manurial constituent of sewage. Did I rightly understand you to say so?—Generally speaking, they are. Like ingredients, having, of course, a like proportionate value, and derived from other sources, find their way into the sewers; but these are small in quantity, comparatively, and for practical purposes may be disregarded.

87. Then, in your opinion, the urinal and solid discharges from horses, cows, and other animals, are not an important manurial element in the sewage. Instead of the term "human excreta" would not "animal excreta" more generally express your meaning?—Strictly speaking, it would be a more correct expression. But I attach little importance to the excreta of horses and cows, which reach the sewers. I would remark on this subject that there is a considerable difference between the excreta of flesh-eating and those of herb-eating animals. The excrement of horses and cows, and of herbivorous animals generally, is not nearly so offensive as human excreta. You must have observed repeatedly, that after a quantity of horse-dung has remained in the road a short time it is not very offensive, and that, after being washed by rain, a mass of whitish matter is left, almost as large as the original. Feeding on matter consisting largely of cellulose or woody fibre, the excreta consist largely of cellulose. The decomposing albuminous matter forms a small proportion of the whole. In consequence of this decomposing matter being locked up, as it were, in the cellulose, and much divided, it decomposes slowly. Consequently the excreta of these animals is much less offensive than that of flesh-eating animals.

88. Then, though in excluding human excreta—if it should be so excluded—from the sewers, you will be taking out all the most unmanageable and offensive elements, you will yet leave some valuable manurial elements in the sewage?—Valuable to a certain degree. Compared with human excreta, horse-dung and cow-dung have an inferior manurial value,

I may be in error in disregarding, to the extent I have done, excreta other than human; but I am not aware that special arrangements exist for carrying the excreta of horses and cows into the sewers, and, in the absence of these arrangements, the quantity of such excreta reaching the sewers in a recent condition, must be small. The introduction into the sewers of these excreta, after long exposure to the air, would create little nuisance. The decomposable matter will have already decomposed. In the absence of trustworthy data as to quantity, I cannot help thinking that the excreta of horses and cows are of small importance, either as a nuisance, or as affecting the manurial value of the sewage.

89. Mr. Councillor Tonks asked you whether a limited quantity of soil, applied for the purposes of the filtration of the sewage, would not necessarily be choked in a certain space of time. I think you answered it would be a miracle if it would not?—It would be both a chemical and a physical miracle if it were otherwise.

90. That answer having reference to the quantity of sewage to be purified, and to the quantity of soil applied to its purification?—Just so.

91. And if a very large surface was employed for the purposes of filtration, and it was divided into sections, and the surface of each section broken up from time to time, and each section also being used singly, and a considerable interval of rest occurring before it was used again, would not that extend the time to a very long period, when, in all probability, the choking you describe would take place?—It would, of course, extend the time. It may be twenty, thirty, or fifty, years before this occurs, but whatever plan of treating the land with our sewage you resort to, in my opinion, the end of it will be, that the land, choked and saturated with the matters poured into it, will lose its power of purification.

92. And in answer to a question addressed to you by Dr. Barratt, I think you stated that, as far as practicable, you would certainly keep all fœcal matter out of the sewage; and that this, in your opinion, will be the only and final solution of the difficulty?—That is my opinion. Mr. Tonks asked me a question which reminds me that the urine of man and animals has not been spoken of, and I think a few words on that subject may be of service. The principal organic constituent of human urine is urea, which, in presence of the mucus of the urine, rapidly passes into ammonia. The process is not very offensive. The essential organic constituent of the urine of stall-fed animals is hippuric acid; this, when the animals are at pasture, is replaced by benzoic acid. Neither of these is offensive.

93. And, with regard to the question of filtration, and the ultimate choking of the filter, which you suppose will sooner or later certainly take place, if the matter to be filtered is deprived of the solid parts of the excreta, and it is distributed for the purposes of filtration over a sufficient quantity of land, the time when this choking would really occur might not be for several, and possibly for many years?—That would be so; but the excreta and organic matters, being kept apart for manurial purposes, you would only have to deal with such solid matters as the drains would furnish, and these would be got rid of by ordinary filtration. I see no difficulty in carrying out a process of that kind. You will not then need this natural filter, the land.

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94. Then these solid matters being excluded—which is a proposition, I ought to say, which originated with Mr. Alderman Hawkes—some time or other, you are of opinion, the nuisance may be prevented by a process of filtration that will be sufficient, by some artificial or mechanical means? —I believe that will be the eventual solution of the problem. Excretal matter being kept out of the sewers, the solid inorganic matter may be separated by filtration, and the injurious dissolved saline matters may be removed by precipitation. The water would then be sufficiently pure to be poured into a river or used for irrigation. We have acted in error in putting excretal matter into the sewers, and sooner or later we shall retrace our steps. The impending litigation requires immediate action. But that action must be regarded as only temporary. Final, I think it cannot be. The task before us is to purify our sewage. That alone, is our primary object. To complicate our task with schemes for improving land would be, I fear, to incur great risk of failure in both.

Mr. Houghton

STATEMENT OF Mr. J. HOUGHTON.

STATEMENT of Mr. Houghton, of Varna Road, Edgbaston, made to the Sewage Inquiry Committee, 29th August, 1871.

I followed farming in the neighbourhood of Aldershot for about thirty years.

I attend here at the request of a committee formed by the ratepayers to observe what is being done in the matter of the management of the sewage.

The committee have directed their attention to the utilisation and purification of sewage. My experience as to purification amounts to nothing. I was engaged in works of irrigation for many years, and have held land and applied all sorts of water to it; but I have had nothing to do with the purification of it by filtration or any other way. I have put on land what is called black water, as well as water from better districts, and have used the sewage of a village. I have put good water from a river on land. I don't think that cost above seven or eight hundred pounds, and we charged the tenants a pound an acre, and the application of the sewage water of a village was proportionately about the same expense, and there was very little difference in the value of the land irrigated with the river water and that irrigated with the sewage water. The sewage water from the village was discontinued for a time, and the meadow was consequently injured. The sewage water produces grosser grasses, which are not so valuable, and we had to put it on again of necessity. I am speaking of the land near Aldershot. I have talked to a tenant at Aldershot on the subject of the process there, but did not hear a word about smells, and I did not myself observe any on the sewage farm. The village is not the Aldershot farm. I should think

the population is from 700 to 1,000. I irrigated about seven or eight acres. I don't know the quantity of sewage I applied.

My general opinion is, that the proposal to use the land in the Tame Valley is as wild a scheme as that proposed in London. The quickest way of using sewage water is by raising Italian rye grass. The application of the Birmingham sewage to land would produce grass enough to keep sufficient cows to supply the whole of Birmingham with milk. I calculate it would take 70,000 families to consume the milk, if the whole of the grass were used for feeding cows. I take it that the proposal is to raise Italian rye grass for cows only. My views are based upon that assumption.

I have considered the question of taking the excreta from the water, and I do not think it possible to separate it from so large a quantity of water. I could produce as much Italian rye grass with the water, and without the excreta, as with it. The sewage would, in my opinion, be quite as fertilising if all those matters were excluded.

I quite agree with Mr. Morton, that excrementitious matters are very valuable, and that the excreta of every man, woman, and child is more than equal to that of a sheep. The excreta of the population of this town is more than equal to that of 350,000 sheep. If these matters were separately collected, and sold in a direct form to agriculturists, their value to them would be equal to a money value of 5s. per head per annum.

The letter in the *Daily Post* now referred to contains my views on the Birmingham sewage question.

I continue to be of opinion that sewage utilisation is a sham, and I discuss sewage purification, which is quite another thing.

I find it a difficult matter in considering how to get out of all the difficulties in Birmingham. No matter whether you adopt the plan of the Public Works Committee or any other plan, in the first place you have not got the sewage in the sewers. What I understand is this: that during a heavy rainfall when the fœcal matter is swept into every corner, the sewer does not take the sewage, and these are the times when it is complained of in the Tame. To meet this I would reduce the volume as much as possible.

The scheme of the Public Works Committee would, in my opinion, cost £12,000 a year. You would not get the land proposed to be taken under £200 an acre, and you would have to take to a large quantity, which would be of no use to you in consequence of its being under flood-water mark. I refer to the part of the land coloured green on the plan annexed to the Public Works Committee's Report, and I estimate that out of the 750 acres, not more than 500 acres would be suitable for the purposes of irrigation, as the remainder is under low-water mark, and you could not drain it without great expense. Supposing you took 3,000 acres of land, I do not think you would get more than £4 an acre for it. If you wanted to irrigate 1,500 acres of the land in the Tame Valley you would require more than 2,000 acres. I estimate that you would have to take off a third of the meadows.

I would prevent all excrementitious matters going into the sewers, and would filter the foul water. I would also prevent the refuse from manufactories going into the sewers. I consider the admixture a disadvantage to the farmer.

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Mr. Houghton

I have tried experiments in irrigation, and my farm irrigated with water produced the same results, with very little difference, as that irrigated with sewage.

I repeat that I believe the estimate of Mr. Morton as to the value of the excreta of each individual to be correct; but if it be mixed with an immense quantity of water, and poured on the land in that state, I maintain that it loses its fertilising power altogether. There is something else which produces the grass and other things—the soapsuds and the dish and warm water. In my opinion, water mixed with soapsuds is quite as good for irrigating purposes as excreta.

I find in the early evidence of the Sewage Committee that the sewage of 2,000 persons has been purified in a very small compass, and I think that three or four hundred acres would purify the whole of the eighteen million gallons of Birmingham sewage. Not more than a field a day would be covered. It is a matter of calculation how long it would take to cover ten acres. If 300 acres were taken, 200 would be in use at one time.

I would not let the sewage subside, but would put it on the land straight. If I had Coleshill Heath I would take the whole of the Birmingham sewage. I could purify it on four or five hundred acres of land, if it were well drained.

I have seen Mr. Blackburn's potato crops, which are very good. He has the value of 100 sheep to an acre, besides the soapsuds. I have produced a better crop of potatoes on a bit of land on the other side of Aldershot Common with two tons of sewage and three cwt. of guano.

I would not use the sewage in the Tame Valley as it is now sent down the sewers.

Mr. Cotterill.

STATEMENT OF Mr. C. F. COTTERILL.

STATEMENT of Mr. Charles Forster Cotterill to the Sewage Inquiry Committee, August, 1871.

I am aware that in some towns in the North of England they intercept the dry from the liquid sewage, but with what result financially I cannot say. The thick liquid sewage is the most beneficial, and, in my opinion, is equal to Peruvian guano. *(a)*

My attention has not been directed to the condition of the sewage if all the fœcal matter were absolutely excluded from it; but I think there is not much difficulty in replying to that, because if you take away the rich portion of the sewage you deduct so much from the manurial value. *(b)*

Supposing all excrementitious matters were absolutely excluded, I have never considered whether the sewage left would be in such a state

as to become a nuisance if dealt with either by filtration or by taking it into the rivers. I maintain that the liquid application is the best, nature being the best filterer and deodoriser; and that you should select upper outfalls, and get the sewage on high grounds, and in order to go over valleys that you should convey it under pressure. That is the theory I laid down in my letter and pamphlet. The liquid manure would not reach high grounds unless under pressure in pipes that would bear the strain. *(c)*

I have had experience in practical irrigation at Cannock only. I have to dispose of the sewage of about two thousand people. The sewage is composed of excreta from water-closets, and washings from brewhouses and streets. The population is about two thousand. The cess-pools have no communication with the sewers. I should think there are not more than ten water-closets. The excreta from ashpits is disposed of to farmers in the ordinary way, by carting it. The sewage of the two thousand people is distributed over about twenty acres of land. When I first commenced my operations, the land, which is high, scarcely yielded any crop; but since the sewage has been put upon it, it has increased four-fold. The crop is ordinary grass. I have used the sewage for about five years. I have found that the crops have increased since the use of the sewage, and that the land is much better than it was. I attribute the benefit to the land to arise from the general sewage, including the excreta from water-closets. The more water-closets the better the sewage; but I do not attribute the value of the sewage to the mere fact of its containing excreta from water-closets. If the ten water-closets were turned off, and not a single grain of excreta found its way into the sewers, I should continue to use the sewage as a fertiliser.

I have had the land during very severe frosts, and the pipes were frozen up. The sewage then flowed over the original meadows. The frost stopped the flow, and prevented the distribution of the sewage over the land. I do not apply the sewage during mowing time. It then runs on to a meadow, and afterwards into the brook, and I suggested carrying it from that outfall in pipes across the brook to the high grounds on the opposite side. When I cannot use the sewage during harvest time or frost, it gets into the brooks and poisons them. *(d)* 5.

No dry manure put on land is of any use until it is liquified either by rain or artificially. It is most excellent when the rain comes. I maintain that the liquid application is the best, and that the dry manure would have no influence, as a dry manure, on dry land.

I could not apply the sewage on the farm during the frost, because the pipes were stopped up, and they are not laid sufficiently deep to stand such an extraordinary frost as the one this year. I am not prepared to say whether I should send the sewage over the land in frosty weather if I could get it from the sewers. I have never made a calculation of the amount of sewage that flows from the village.

The farmer says the grass is excellent, what he means by "excellent," whether quantity or quality, I cannot tell. He is very much pleased with it.

The thicker the sewage the slower the movement would be, but the better for the land.

My experience is that of an engineer; at least, more so than that of a farmer.

The two upper outlets I suggest would be in Gooch Street and at

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Hockley Brook. I consider these two points very important. My principle is elevation by pressure, and to start 40 feet higher than Saltley. I have formed a strong opinion that the benefit of applying sewage to *high* lands is so much greater than applying it to *low* grounds, that it will much more than compensate the additional expense; and I further say that, in my opinion, if a proper system of hydraulic pressure be adopted, the additional expense would be very little. On high grounds, at twopence per ton, the Birmingham sewage would come to £240,000 per annum, whereas, on the low grounds, at one farthing per ton, it would only be £30,000 per annum.

(*a*) This requires a little explanation. For example, suppose £10 were spent in Peruvian guano, and the farmer were supplied with sewage at 2d. per ton, he would have 1,200 tons of sewage; and on an average of seasons, being a liquid manure, it would yield a larger and better crop of grass than that from the Peruvian guano; always bearing in mind that the application of liquid manure is of *immediate* benefit, but that of dry manure is only beneficial after rain.

(*b*) If all excrementitious matters were entirely excluded from the sewage, the remainder would be the same as ordinary brook or river water, and the application of even this to lands is beneficial, as attested by irrigation meadows in every parish in England.

(*c*) The difference between gravitation and hydraulic pressure is not generally understood, in reference to sewage.

By gravitation, liquids generally run *down* hills in culverts or pipes. This is very simple, and what anyone can design and execute; but by hydraulic pressure the *weight* of sewage or water on one side forces it up to the same height on the other; and this can only be effected by the culverts or pipes being sufficiently strong to bear the weight.

Gravitation irrigates *one* slope only, but hydraulic pressure *both* slopes.

(*d*) With regard to frost the last winter was quite exceptional, and the sewage and water pipes were *equally* frozen up. This, however, can always be obviated by their being laid sufficiently low.

During mowing time the sewage is turned on to the original grazing meadow, which absorbs the whole quantity except during floods. In ordinary times it takes the whole of the sewage, but during floods or very wet seasons the superfluous quantities which formerly ran into the brook are now conveyed over the brook on to high lands on the opposite side. The pipes are earthenware, and they convey the sewage under pressure.

The experiment is, however, on a *small* and *imperfect* scale, but it illustrates a *great* and *abiding* principle.

STATEMENT OF MR. EDWIN CHESSHIRE.

STATEMENT of Mr. Edwin Chesshire, surgeon, made to the Sewage Inquiry Committee, 29th August, 1871.

I am Senior Surgeon of the Birmingham and Midland Eye Hospital.

I have given my attention to the mode of taking the fœcal matter out of the urine. So far as regards the solid matter, that has been done by the catch-box I have patented. It has been in use, not only in this country, but in Bombay and Norway, since 1865. The object of my patent is to collect the solid excreta only, which goes into a box hermetically sealed. The urine goes through a perforated plate into the sewer. The box is 28 inches long, 18 inches deep, and 18 inches wide, and receives the excreta of three or four persons a day. It receives the fœcal matter, and does not require to be changed more than once in six months, and during that time does not emit any smell. I have duplicate boxes, which would only require to be changed once a year. The price of the box was originally 37s. 6d., but owing to an arrangement with the manufacturers a deduction of 20 per cent. might be allowed if the box were made of wrought iron, and 30 per cent. if made of cast iron. I have had a box in operation seven years without being repaired once. I produce a description of it.

I assume that the point is to keep the excreta from the rainfall sewage.

(Mr. Chesshire here read paper marked B, appended hereto).

I have watched the discussions in Birmingham with regard to passing the sewage, including the excreta, bodily on to the land by gravitation, with a view to utilising it. If the whole of the fœcal matters were turned into the sewers, I think the effect in the lower and more crowded portions of the town, through which the mains pass, would be very bad; but it would be most felt in the house drains.

Dr. Farr states the mortality of Birmingham to be practically 27 per cent. Dr. Hill, the Borough Analyst, says there are large quantities of organic matters in the wells which, in my opinion, arise from the bog-holes and drains.

The rain from the roofs goes into the sewers, and only when heavy rains take place is the drain flushed. In the meantime the fœcal matter is clinging to the house drain, and if the water-closet happens to be imperfect, the gas gets back into the house. If a system of drain flushing were adopted, and the whole town should send its fœcal matter into the sewers, I think it would add to the injuriousness. I do not think it possible to flush the drains. Nothing but a thunderstorm will do it. This is in consequence of the glutinous kind of material, as well as the want of fall.

The effect of vast quantities of washings from manufactories going into the sewers depends upon their chemical properties, but, on the whole, I think it is disadvantageous. This would not be so as regards sulphate of ammonia, which is not a volatile material, and if it passed along the sewers would go for a manure of the finest fertilising quality. I have not sufficient experience of the kind of refuse turned into the

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sewers by the manufacturers to give any opinion as to its effect; but, judging from my knowledge of what the manufacturers of metals send into the sewers, I should stop its introduction.

I think that if the Birmingham sewage is turned on to land in its present state, it will have a prejudicial effect. The ordinary agriculturist does not even put stable manure on his land in a recent form, but allows it to decompose. On my own land, recent manure has burnt up the crops. My impression is, that in a town like Birmingham, where there is an immense number of children, vast numbers of them must have different forms of tape-worm, and if sewage irrigation be adopted, tape-worm would be propagated through the animals and come back. In my opinion, any large tract of land irrigated with town sewage would be prejudicial to health, and in the way I have described for one.

My theory is the absolute separation of solid excreta from the liquid. The solid, I suggest, should be retained in the receptacles I have named and collected at long intervals, and the liquid passed through some process of filtration by charcoal or other material. The filtering is an experiment. With reference to the liquid, I propose to deal with it as described in the paper marked B, paragraph 4. There would be an additional expense in respect of the experiment. I estimate that the second receptacle would not cost more than 10s. Some portion of the solid excreta escapes through the perforated gratings of my interceptors. The difficulty is not to retain the solid, but to get rid of the liquid. I believe about 6 per cent. of the solid excreta escapes.

I have examined the analyses of Professor Voelcker and Dr. Hill, but am not aware that the only refuse from manufactories detected by them is sulphate of iron. In my opinion, it would not be desirable to exclude the sulphate of iron from the sewage on sanitary grounds. With reference to the decomposition of the sulphate of iron, and the consequent formation of sulphate of ammonia, it might be desirable to retain it, supposing the urine to go into the sewers.

My patent would not involve the necessity of a separate sewer, but would render the present system of sewerage more practicable. I should prefer a separate conduit to convey the filtered liquid to some district. Mine is a double system. The separate system has been adopted, but not in the way I should propose. I propose to take only the liquid in the conduit. I am advised that a nine-inch pipe would take three quarters of a million gallons per day, and the flow from the water-closets would not be more than 100,000 gallons a day.

I have calculated the value of the excreta. I take the number of water-closets to be 15,000, and I consider each interceptor worth 15s. a year. I have not calculated the value of the urine.

No inconvenience arises from the removal of the intercepting box. Dr. Parkes has been to my house and had the lid off, and examined it with his test papers. Mr. Till, the Borough Surveyor, was also present when one box was emptied.

My proposition is not to put anything in the rainfall sewers. Assuming that the whole of the liquid and solid excreta went into the sewers, the gases produced by the decomposition generated in the sewers would be deleterious to health. I hold that the mischief is not in the sewers, but in the drains, where the decomposition takes place. Anything in motion will not decompose.

I am aware that the men employed in dealing with the excreta enjoy

fair health, but this I attribute partly to their habit of early rising, and there is a good deal in being acclimatised. Men working where gases are largely thrown off enjoy fair health, but I do not know that they enjoy exceptional health. I am not aware that you can pass through districts affected with malaria in the daytime with impunity, and be affected by it by night. The effect of the exhalation of the gases on women and children would be most prejudicial. I do not think malaria a proper term for exhalation from cesspools, but rather emanations. The rapid decomposition of bogholes does not commence the moment they are exposed to the atmosphere, but after exposure.

B 1. The excreta of the population of the borough to be intercepted at the fountain-head and not to be mixed with the rainfall sewage.

2. The solid portion of the excreta to be separated from the liquid, also at the fountain-head; the solid portion to be retained in "sanitary interceptors," while the liquid portion is passed into a second receptacle on a lower level, and then filtered through charcoal.

3. The liquid portion of the excreta from dry closets, the urine, to be caught in barrels, or, having been filtered in a second receptacle as above, to be passed through sanitary pipes into a covered tank at the final outlet with the water-closet liquid, as under.

4. The liquid from water-closets, after having been filtered through charcoal, as above, to be passed through a two-inch sanitary pipe into a nine-inch sanitary pipe running along the top of the inside of the main sewer, but a little on one side, and extending throughout the sewers to the tank placed at the sewers outlet.

5. The liquid excreta sewage then to be passed from the tank by gravitation through a twelve-inch cast-iron main laid along the banks of the Fazeley Canal, stand-pipes being placed at suitable intervals, from which sock-carts may be filled with liquid excreta sewage as water-carts are now filled with water, but by gravitation only; the first stand-pipe to be placed at a convenient situation for the supply of the sewage farm at Saltley, from which the liquid excreta sewage may be drawn into sock-carts or be applied to the sewage farm with pipe and hose.

6. An overflow pipe to be placed in the tank, which shall communicate with the sewage farm, where the overflow, if any, may be utilised. Should the present sewage farm at Saltley prove to be insufficient to absorb the whole of the surplus liquid excreta sewage, an additional quantity of land must be taken, either at Saltley or in any other locality through which the main passes, in order to utilise the whole of the overflow liquid sewage.

8. All bogholes or middens to be abolished.

9. Should it be required, another nine or twelve-inch cast-iron main might be laid along the banks of the Warwick Canal, for which, in this case, the liquid excreta sewage would have to be pumped to the level of the top lock at Camp Hill.

Appendix XI.

Mr. Chattock.

STATEMENT OF Mr. C. CHATTOCK.

STATEMENT of Mr. Christopher Chattock, made to the Sewage Inquiry Committee, 29th August, 1871.

I have been a land surveyor and agent, at Castle Bromwich, for upwards of twenty years.

I have given my attention to the subject of the purification and utilisation of sewage. The letters which I have addressed to the public through the *Daily Post*, in June and July last, express some of my views; but there are additions which I should like to make. The general scope of those letters is condemning the whole system of sewage irrigation. I specially condemn it as unsuitable to the locality of the Tame Valley, by reason of its situation and the character of the soil.

I have a plan for the utilisation and purification of the sewage of this borough.

The principal objection to sewage irrigation is the climate, which is 53 degs. north latitude. The sewage of Birmingham, or any other town, cannot be utilised, because land in such a climate is not adapted to perpetual irrigation. Irrigation, in the ordinary sense of the term, existed before sewage was thought of. Sewage irrigation would compel a perpetual saturation. If the number of gallons are positive, and increasing annually, and you have to apply it to a certain number of acres, there must be a perpetual saturation. The soil of England, which is of a clayey or marly nature, is productive, but does not require perpetual saturation. Human excreta being of a plastic nature, is more adapted to mix with a clayey soil; but the latter can dispense with the liquid—that is, the surface water. The other soils are gravel and sand, which are adapted to receive sewage irrigation, but it does not mix or commingle. If the land proposed by the Public Works Committee were saturated, the east wind would drive the evaporation into and pollute the town.

I have a plan for getting out of the difficulties in Birmingham, which I would disclose on payment of a fee.

I am familiar with the land which the Public Works Committee recommend should be purchased for irrigation. I consider the whole of it too low. With regard to its constituents, I have described that in one of my letters, and I still stand by it.

If I could have the sewage whenever I liked, I might put it on land which had never had it before. As a change of manure I might adopt it. I consider the excreta better than any guano, if it were arrested before going into the sewers; but not as it is delivered at the Sewage Farm. I would not have the liquid on any account.

A large tract of land—say 1,500 acres—under sewage irrigation, would, in the case of an epidemic, produce frightful consequences.

I am not aware that land has been under irrigation, near Edinburgh, for upwards of 100 years. It is possible to irrigate a sand bank for a number of years, but it must receive accessions of fresh sand.

I would not have the sewage in its present state except under very exceptional circumstances. It is not fertilising except on new land.

I think that unless a sewage farm is more than a mile and a half from the borough boundary it is very dangerous.

STATEMENT OF Mr. A. BIRD.

Worcester Street, Birmingham.

Thomas Avery, Esq., J.P., Chairman of the Sewage Inquiry Committee.

Dear Sir,—According to promise, I respectfully submit for the consideration of yourself and Committee, a few *ideas* which have occurred to me, on the difficult question of the disposal of the "town sewage."

In order to form a clear conception on the subject, it will be necessary to consider, "What are the *natural laws* by which it is dealt with?" for it is a fact, that though the sewage of Birmingham goes into the Tame, yet, at Tamworth Bridge, fish will live.

It is certain, therefore, that if you give sufficient *time* and *distance*, there is a tendency in the fluid of the river to purify iiself.

This tendency depends upon two natural laws—1st, the law of the oxydation of the organic matter and 2nd, the law of subsidence.

As to the first law, namely, the oxydation of the organic matter, this proceeds with extreme rapidity, the effect being, that organic matter which was in solution becomes insoluble, which (if the fluid is still, or slowly flows) will rapidly subside.

As the particles are precipitated, they cohere together, and thus, being somewhat heavier, they will no longer diffuse themselves in the fluid, but will, when disturbed, soon settle again to the bottom.

The second law, namely, subsidence, not only deals with all those matters which have been rendered insoluble by oxydation, but it deals with that which has been held in the water by "mechanical suspension," and which is caried down the stream by the mere force of the current.

As, therefore, the Tame becomes pure at Tamworth Bridge, the question arises, How many miles in distance might the sewage of Birmingham flow to purify itself?

In order to answer this question, it is necessary to inquire into the nature of the sewage.

I have examined a gallon of the sewage (furnished to me by the kindness of Mr. Till, and collected at the mouth of the sewer in the middle of the day,) and find that the total solid contents in a gallon of the sewage was but 80 grains, 30 grains of which subsided with great rapidity, leaving a clear supernatant fluid, slightly coloured, and free from smell.

On examining this fluid, I found in it a considerable quantity of sulphate of iron. This is an important fact, as it shows that there is not sufficient available alkali, either ammoniacal or otherwise, in the sewage, to decompose the "iron salt."

The sulphate of iron must therefore flow off as sulphate of iron, *and it is this salt which is so hurtful to vegetation, and so deleterious to fish.*

In proof of that, I may mention that a short time ago a sample of water was taken out of the river Cole and was brought to me for analysis in consequence of several dead fish having been seen on the surface.

Appendix XI.
Mr. Bird.

On examination of the water I found it heavily charged with sulphate of iron; its presence being, without doubt, the cause of the death of the fish.

Having said thus much, by way of preliminary, I now allude to the contention of Mr. Adderley with the Corporation.

It seems that, by the terms of the injunction, the Corporation is not absolutely prohibited from running the fluid part of the sewage into the Tame. It only says that it shall not run into the river "so as to be a nuisance."

The question then is, What constitutes the sewage a nuisance?

The obvious answer is, "If the sewage is offensive to the sense of smelling, and if it kills the fish in the river, then, such sewage is a nuisance."

With reference, then, to the smell. If I am to judge by the sample sent to me by Mr. Till, the sewage at the mouth of the sewer has no smell whatever, and it is reasonable to expect (which is the fact) that it will continue inodorous when it runs as an open stream, as three sides of the channel—that is to say, the bottom and sides—are hermetically sealed from the atmosphere, only the top of the stream being exposed; but the sewage matter being under, and surrounded by, water, even at the surface there are no emanations as it flows on. And I am of opinion that the enormous quantity of water contained in the sewage is extremely favourable for sealing up, as it were, the sewage in the water, till it is decomposed by the oxygen therein contained.

On the other hand, if fœtid smells are allowed to rise, no surer method could be adopted for liberating them than spreading the fresh sewage over a large surface for the purpose of drying it, or for irrigation. The result must be to create an intolerable nuisance, which will be certain to be followed by "injunctions" wherever it is done, because it is virtually an attempt to oxydise the organic matter by the air, instead of its being done by the oxygen contained in the water and under the surface.

If the sewage of Birmingham flowed in a channel of its own, *how far down* such channel, and what time it would take for the solid matter to subside, so as to allow the water to flow off clear, can only be known by actual and careful experiment; but I am quite sure that if the gradient of the stream be not too great, so that the stream shall flow off slowly, two or three miles would make a great change in the water towards pellucidity.

I now come to the poisonous action of the sewage water on fish; and here I am obliged to say that the want of sufficient alkaline decomposing power in the sewage to act upon the iron, zinc, and other metallic salts, renders it absolutely necessary that such metallic solutions should be decomposed at the works where they are produced, and the Corporation should take "peremptory powers" to enforce this rule upon all manufacturers.

The clear water from the sewage, being deprived of its metallic poisonous ingredients, would not then be hurtful to fish, and I am of opinion that the reason why fish live at Tamworth Bridge, though the sulphate of iron remains in the water, is in consequence of the solution being more and more diluted as it goes down the stream, till its poisonous effect on the fish disappears.

Bearing in mind, then, the above facts, the obvious conclusion as it appears to me is, that if the Corporation will act according to nature's laws,

the first thing to be done is to keep out of the sewage the poisonous metallic salts, and, secondly, to so arrange matters as to keep the sewage as long as possible *under water*, till its offensive matter has become inert. And how is this to be done in a stream that is constantly running? To which I reply: let a channel be formed for the sewage, along which it should *slowly flow*, so as to give time for oxydation and precipitation, and the clear water running off, no longer containing poisonous metallic salts, would cease to poison the fish, and Mr. Adderley's contention would be met.

As I said before, how long such a channel should be can only be ascertained by experiment; and with reference to the periodical cleaning out of the channel, I am of opinion that, unless close to the town, it would not require doing more than once in two or three years, and there might be two constructed, one to be in use while the other is cleaned out, with a small tramway beside or between them to carry off the settled and consolidated mud to a canal or any point required by the farmers.

Some well-devised experiments should be conducted to settle the question where, up the stream, and how near to Birmingham, would fish live; for it must not be forgotten that fish, being of a low organisation, will live upon products derived from organic matters, if the water is not poisonous. The whitebait fish in the Thames, at Greenwich, is an instance of this.

A fish in absolutely pure water would starve to death.

Before I close this paper I will take the liberty to allude to the two plans which have been submitted to the Corporation. The one is the precipitation of the sewage by chemical means, the other is the disposal of the sewage by irrigation.

As to the first—the precipitation of sewage by chemical means—the best process depends upon the liberation of free alumina from its solution, on the principle of my patent for the purification of drinking water with the neutral ter-sulphate of aluminium.

This is the cheapest and best agent for doing it, but I find that it takes sixteen grains of the salt to precipitate all the soluble organic matter in a gallon of sewage, and, though 7,000 grains of the salt cost but a penny, if every gallon of the sewage had to be treated with sixteen grains of it, the cost of the precipitant would be enormous.

It would also require a place as large, or larger, than the sewage works at Saltley, and would be as great a nuisance.

As to the irrigation scheme, unless the sewage stream, when it emerges from the sewer, runs like a "mill race," the solid suspended particles will fall to the bottom of the channel long before it reaches the point of distribution over the land, and the channel would have to be cleaned out by some process like what I have suggested.

If the stream in the channel runs slowly, so that the clear water only shall reach the place of distribution on the land, it shows a want of discernment to propose to purchase land to distribute it upon, when its natural course is to run into the river; and it is clear that, if the Corporation determine that the whole of the liquid part of the sewage shall go upon the land, as the town gets larger and the sewage gets more in quantity, it will require a whole county to absorb it.

I need only hint at the worthless character of the liquid sewage for fertilising land, owing to its extreme dilution, to say nothing about its deadly action on vegetation while the iron salt is contained therein; and I con-

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clude by again urging on the Committee that the proper method of dealing with the town sewage, and which is according to nature's law, is to leave it under water as long as possible, where it is a nuisance to no one, and in which position it offends not the sense of smelling. But if the Corporation is determined to buy land, for the purpose of spreading or diffusing the fresh sewage over it, they must not be surprised if hostile action is taken against them, go where they will.

I am, dear Sir,

Yours faithfully,

ALFRED BIRD, F.C.S.

APPENDIX XII.

APPENDIX XII.

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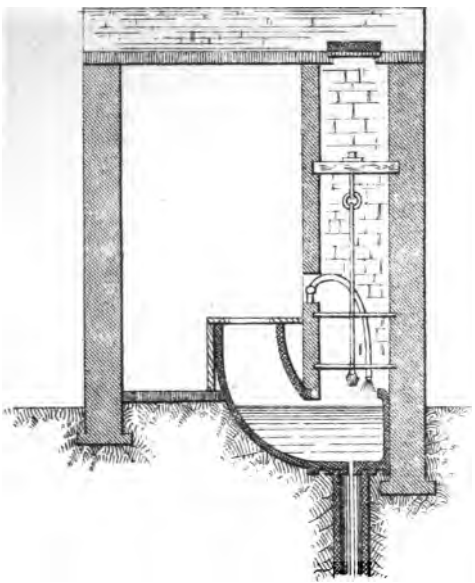
Rochdale Dust Cart	8

LIVERPOOL. TROUGH WATER CLOSET.

PLATE I.



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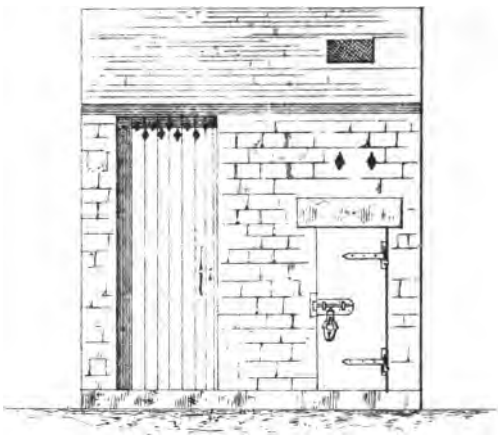
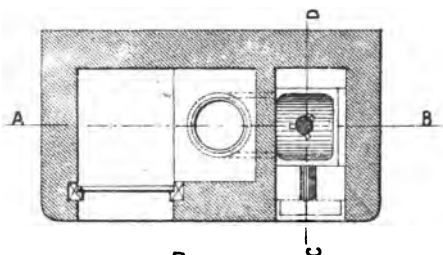
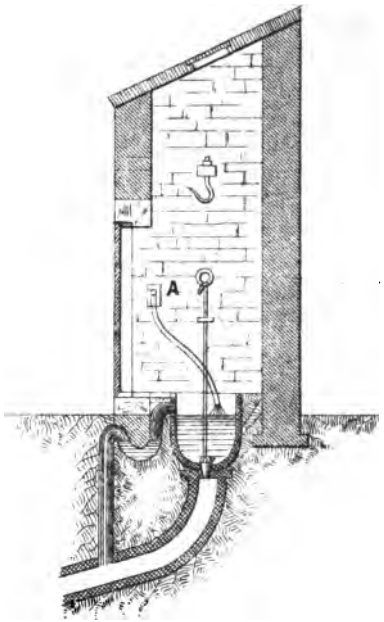


ELEVATION



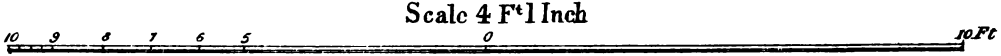
PLAN



SECTION THRO C.D.

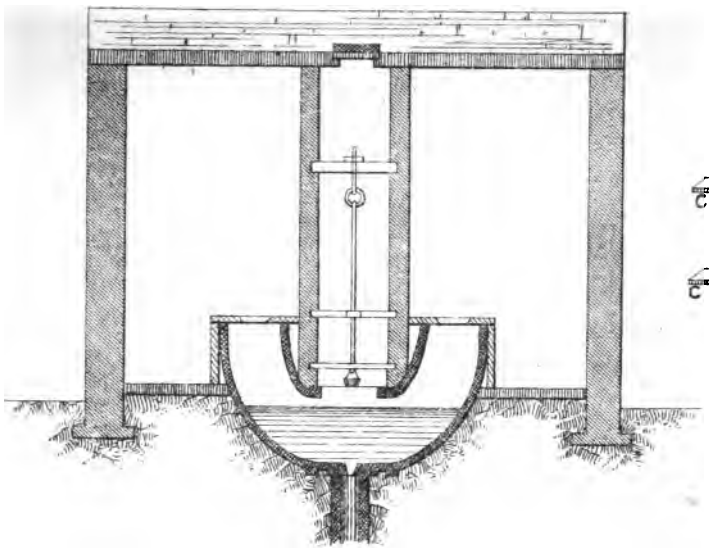
A Water Supply from Hydrant with Hose inside Chamber

Scale 4 F^t^ 1 Inch



LIVERPOOL. DOUBLE TROUGH WATER CLOSET

PLATE II.



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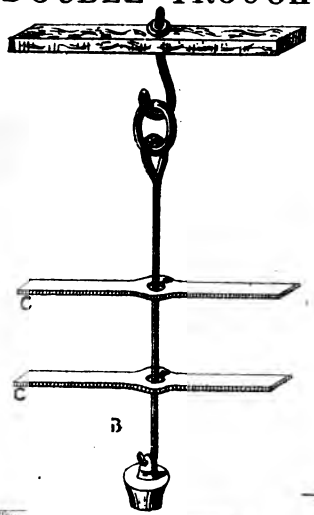

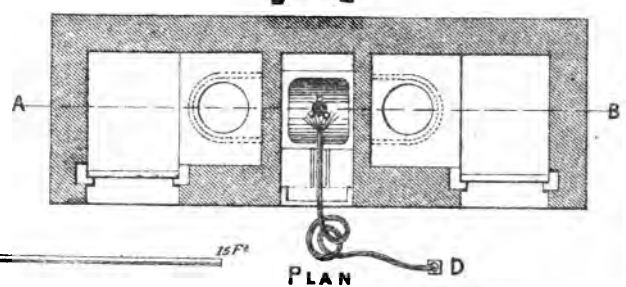

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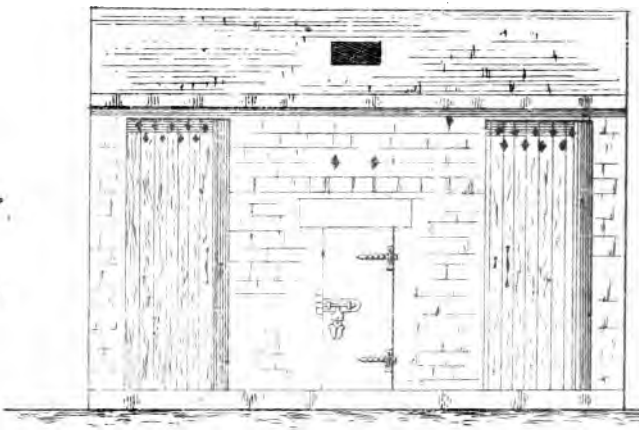


ELEVATION

B Enlarged Drawing of Valve Guide rods (C) &c
D Water supply with Hose from Hydrant fixed in Court

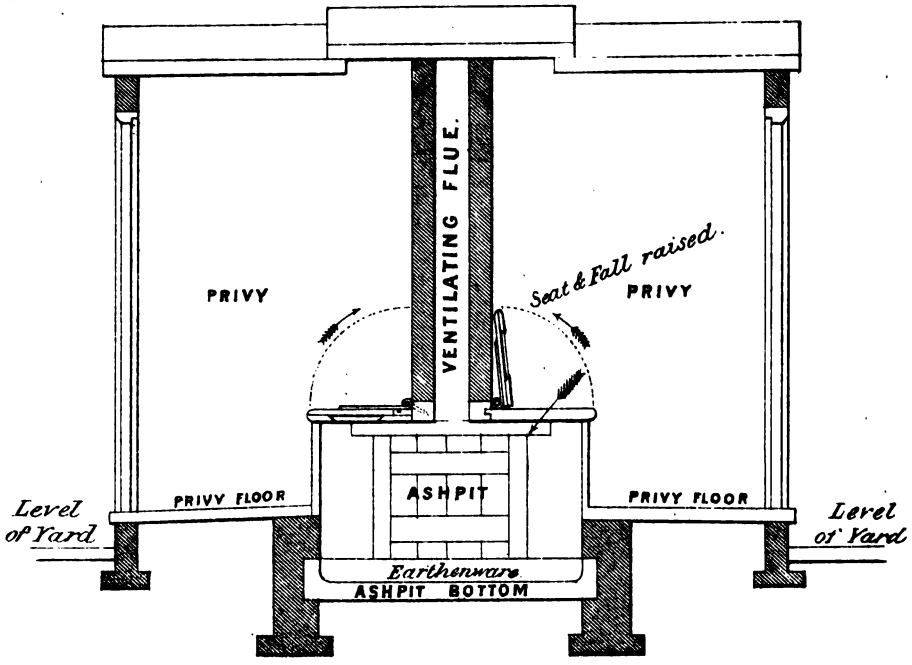
Scale 4 Ft 1 Inch

0 1 2 3 4 5 10 15 Ft

MANCHESTER.

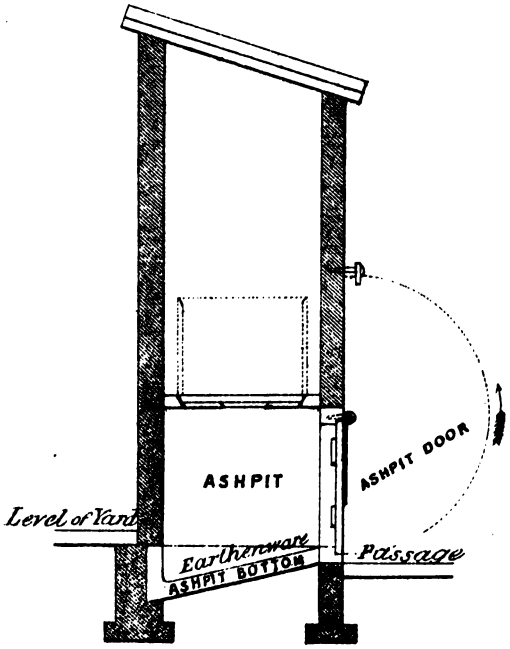
PLATE III.

DETAIL DRAWING OF PRIVIES & ASHPITS.



SECTION ON LINE A.B.

Section on Line C.D.



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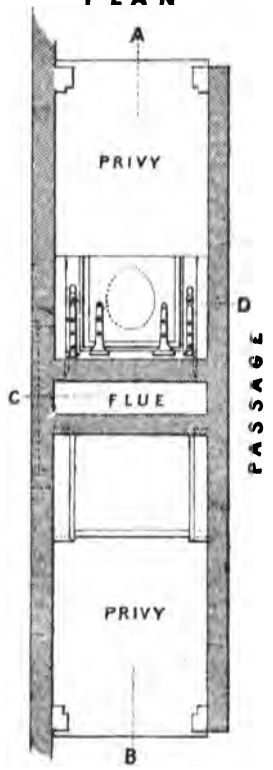
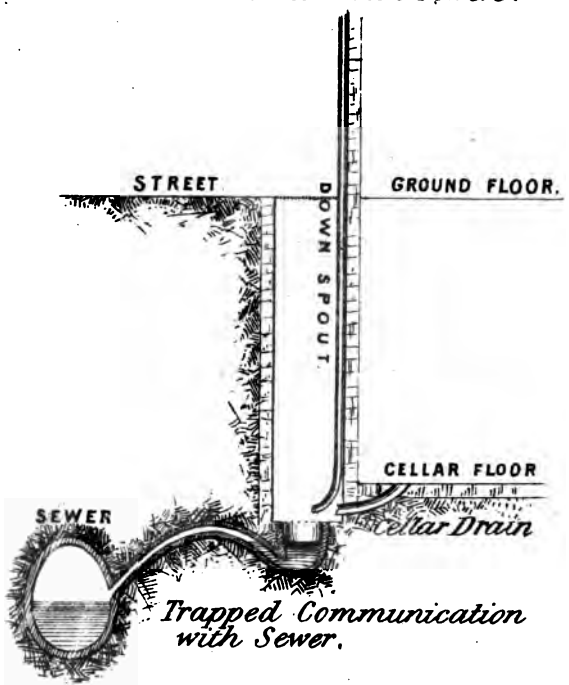


MANCHESTER.

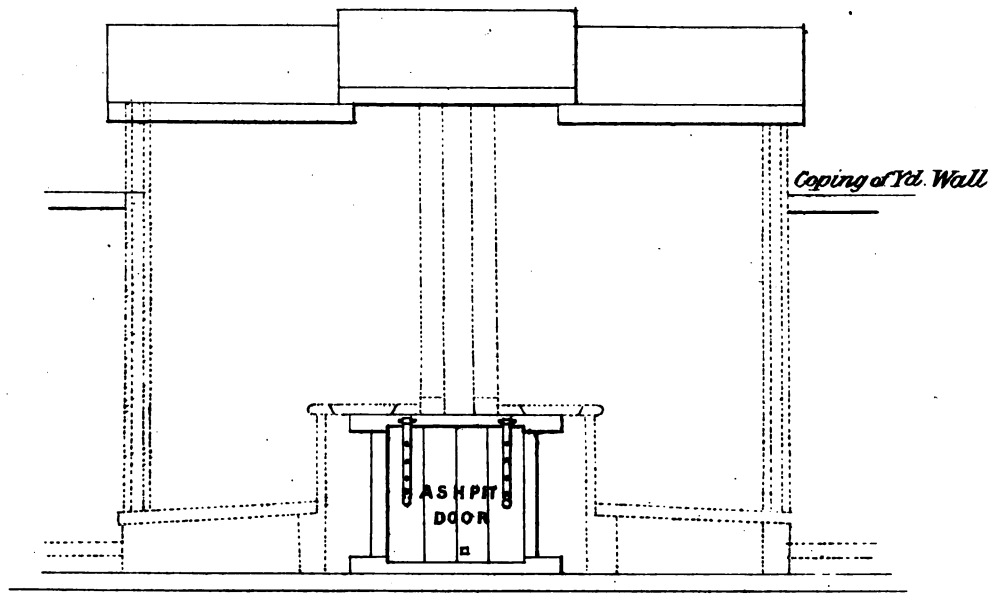
PLATE IV.

Improved Method of Communication with Sewers.



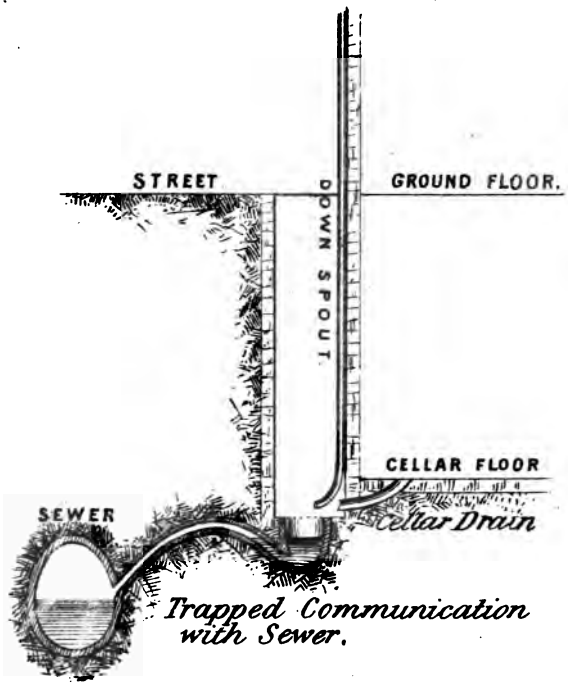
Trapped Communication with Sewer.

Elevation of Privy in Passage.



MANCHESTER.

Improved Method of Communication with Sewers.



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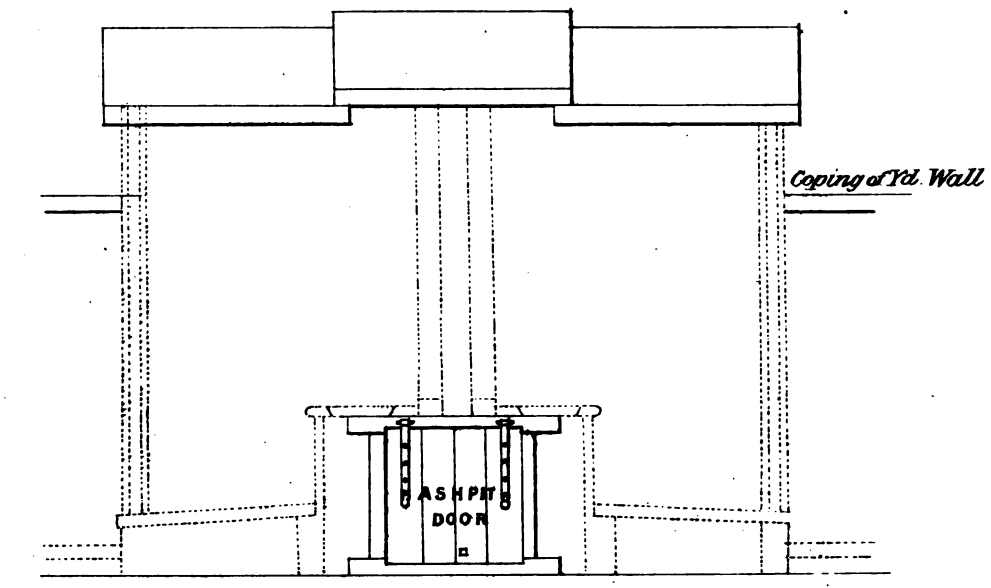
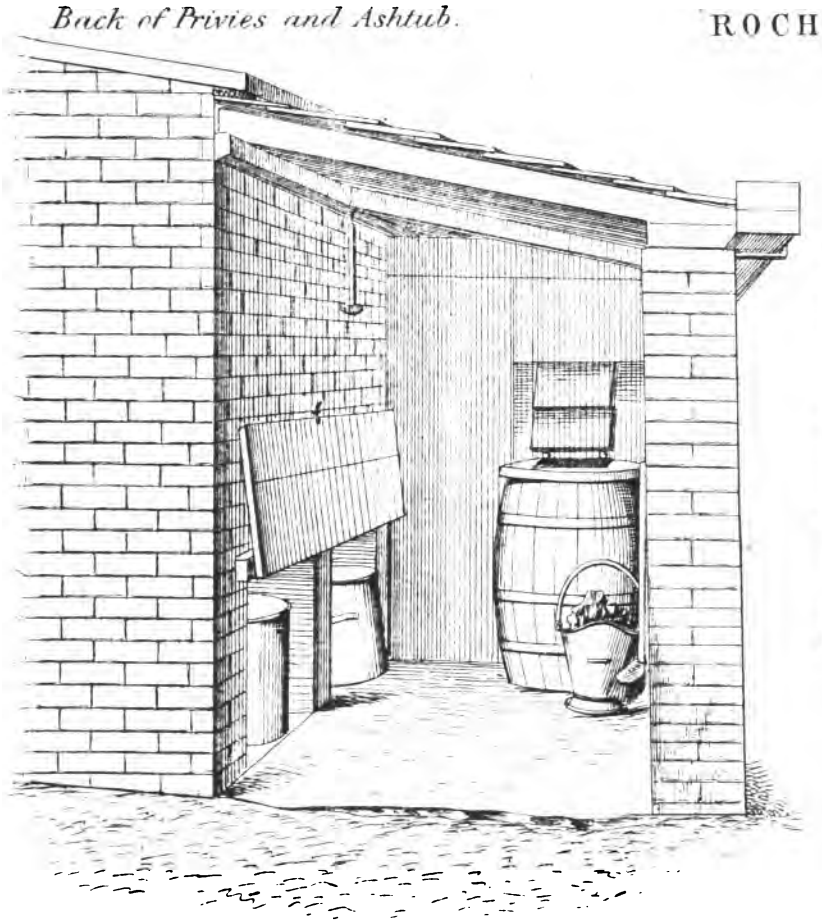
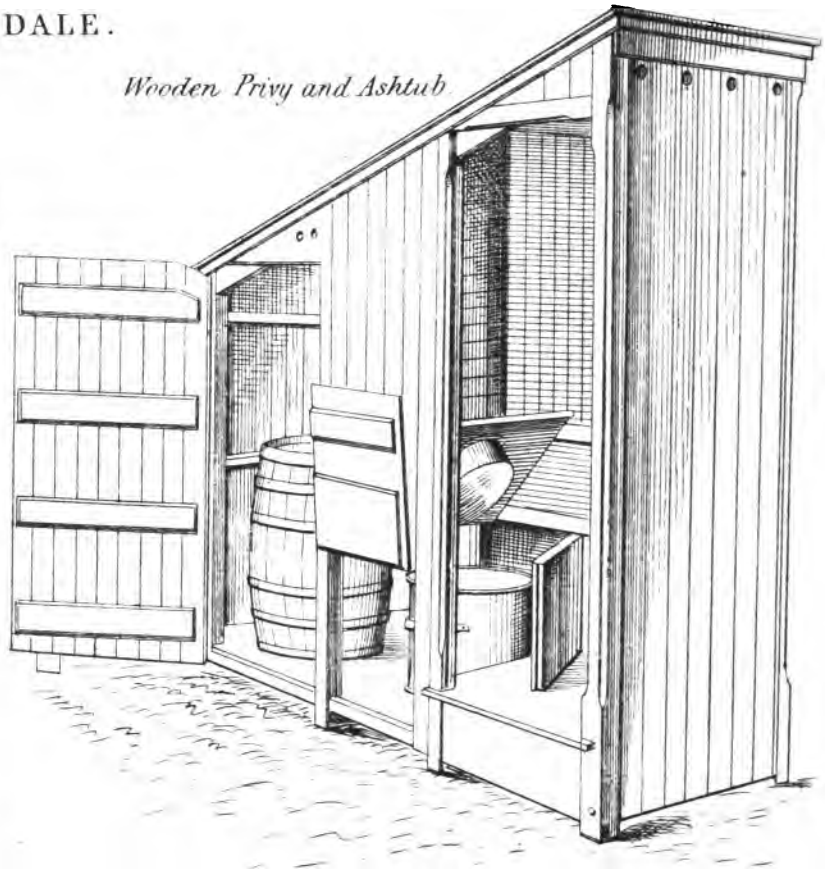


Back of Privies and Ashtub.

ROCHDALE.

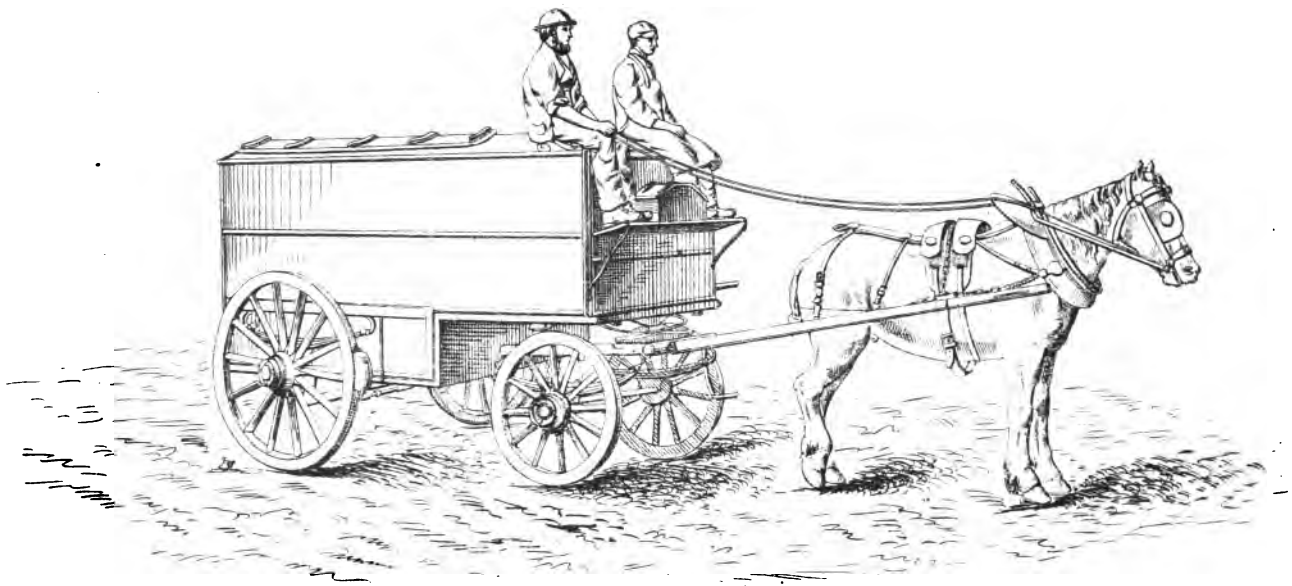
Wooden Privy and Ashtub





ROCHDALE.

NIGHT SOIL VAN.



ROCHDALE.
NIGHT SOIL VAN.

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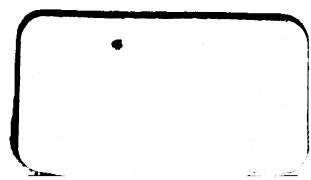
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